THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

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Founder and First Editor
(1911-1939), C. G. GREY

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IMPROVING COMMUNICATIONS

HARDLY has a round century elapsed since Stephenson's Rocket began hauling men and freight along steel rails. In that time progress in transport has been phenomenal. Even a year or two ago the likelihood of man achieving a near miss in a shot to the moon would have been discounted most everywhere; today it will surprise nobody to hear an unconcerned announcement of the actual miss-distance being given by a B.B.C. newsreader in the 8 o'clock morning news bulletin.

However important as we know the question of astronautics to be to the British aircraft industry which will, in the end, have to produce the hardware, we are more concerned this week to lay before our readers some thoughts about the equally vital business of air transport. It is already widely known that B.E.A. is going in a big way after the business of carrying millions of our fellow countrymen to and from their holidays. Big though the market may be for moving businessmen and technicians about this country and the rest of Europe, B.E.A. have turned their sights onto the 18 millions of workers in Gt. Britain who, by and large, do not make use of the facilities which the air transport business is in a position to offer them when it comes to going for a holiday. This B.E.A. enterprise is praiseworthy and we do not imagine for a moment that we have heard the last of it.

It was not an accident that we began this discourse with a reference to the pioneer railway engineer. If B.E.A. and B.O.A.C. are nationalized undertakings so are the railways. Interestingly enough the same minister is responsible for both forms of transport. If the airlines are not doing too well, the railways are certainly doing much worse. This seems strange. And before spending vast sums on modernizing the railways it might be a good thing to see if aircraft could not carry more of the traffic for less money.

There was a time when this country might have been regarded as a gigantic farm providing food for the inhabitants. That has not been true for a long time and even the recent efforts to build a healthy farming community have not altered the situation basically. What this country might be likened to, much more truly, is a gigantic factory—and a factory with a widely diversified output and a very important export trade. Indeed the health of what we might in this context call the national farm is inextricably mixed with the health of the factory's export business. Now anybody who has anything to do with running a factory, and particularly a factory with widely spread plants, knows that an essential part of the organization is good communications in the widest sense. People must be able to get about quickly from one plant to another and then back to headquarters.

Unlike the conventional aeroplane, the helicopter is a VTOL aircraft which can literally lift the factory manager or director off the roof of the plant and put him down on the roof of his company's main office in the nearest town or the distant metropolis. The remarkable thing is that the helicopter is hardly used at all for this purpose. It has been adopted by the Royal Navy not only for military duties but for life-saving rôles. It is used to a limited extent by the Army. But in civil use it might be said not to occupy the attention of our national airlines at all and indeed for commercial application its development is being largely undertaken by private undertakings. And great credit is due to them. However, if one accepts the idea that the country should be regarded as a gigantic factory with a vitally important exporting business, it behoves us vigorously to set about investigating the possibilities of using helicopters to get key engineers and executives around their duties more speedily.

We have no idea what the independent air transport operators are going to talk about at their forthcoming annual dinner, though this function will have taken place by the time these words are published. It is a fairly safe bet that some attention will be drawn to the plans of B.E.A. for entering the inclusive tour business. It is an almost equally safe bet that nothing will be said about the possibilities of using helicopters to move people about the country quickly. If one goes to a particular case we have the Fairey Rotodyne, which made its first flight exactly a year ago. It has done a very great deal of flying indeed and, if it has not done more, this is the direct result of Government parsimony in the matter of engine development. Here is a development of the helicopter which can carry a load of 40 passengers at cruising speeds approaching those of conventional aircraft. It can lift them up and put them down with rotary-wing safety from the surface of large tennis courts. Operators from the United States and Canada do not need to be impressed with the possibilities; they would buy developed aircraft today. But there is no programme of utilization or development.

We have often said in the past that the Minister of Supply needed a director of helicopter development; today that busy and energetic man, the Minister of Transport, ought to have a director of helicopter utilization. It is too early yet to expect our national airlines to undertake the job.

MATTERS OF MOMENT

Help for the Industry

IN the course of the debate on the Queen's Speech in the Commons last week, Sir David Eccles announced that up to seven years' credit could be given by the Export Credits Guarantee Department in future, in respect of certain British aircraft and engines for export. The phrase used by Sir David was "large British airliners and . . . the engines used in such aircraft." This presumably covers such types as the Viscount, Vanguard, V.C.10, Argosy, Comet, D.H.121 and Britannia; whether smaller aircraft like the Dart Herald and the Bristol 205 and Hunting H.107 projects are also covered is not clear.

The British industry has for long been at a serious disadvantage when selling in competition with American aircraft financed through the Export-Import Bank. Government credit in support of export sales has been limited to five years, whereas seven and even ten-year loans have been easily arranged for U.S. types. The new regulation, which Sir David described as an "exceptional step," should help to meet this competition, although it is now too late to be of benefit in several cases where British aircraft might well have been sold had it been possible to offer these better terms a year or two ago.

Astronautical Progress

AT long last there are signs that some positive steps towards British participation in practical astronautical affairs are being taken. This, as regular readers are well aware, we have long advocated. The reports that Prof. H. S. W. Massey, F.R.S., of University College and the leader of our International Geophysical Year efforts, has advised the Government that a British attempt to launch a satellite should be made, will be welcomed by many people who believe that it is imperative that Great Britain does not fall behind in the general march of progress from aeronautics to astronautics.

This, it has been suggested, could be done with the aid of de Havilland's Blue Streak long-range ballistic missile and the Saunders-Roe Black Knight high-altitude research rocket. The project, it is said, would cost less than 10% of the associated defence expenditure—a small price to pay for a place in space.

Matters of this sort have been very much in the news recently. Last week-end, for example, Prof. Lovell, of Jodrell Bank, started his series of broadcast Reith Lectures, "The Individual and the Universe." But perhaps more directly concerned with artificial satellites and man's attempts to explore space, has been a learned discussion on an international plane held during the early part of this week. This was a two-day symposium on space research, organized by the Royal Society. It was under the chairmanship of Prof. Massey, who doubtless would explain the part that Great Britain could play.

These discussions, which are being attended by large and distinguished delegations from America and Europe, have been planned to examine the contribution that can be made by artificial Earth satellites to scientific knowledge generally. Orbit control and the limitations arising therefrom; tracking problems; and the recovery of data, all come within the scope of the talks. And they are to be followed today and tomorrow by the first meeting of the International Commission on Space Research which has been formed to extend international scientific co-operation into the astronautical field without inter-Governmental commitment.

Last week we reported the suggestion put forward by a distinguished British aeronautical engineer that what was wanted was a Minister of Aviation and Astronautics. Without such co-ordinating authority no progress is possible.

The A.B.A.C. and the Facts of Life

FACTS and figures produced at November 7's annual dinner of the Association of British Aero Clubs show that there is more private flying in this country today than there was in the movement's pre-War "heyday" although, as one speaker said, there's not so much fun.

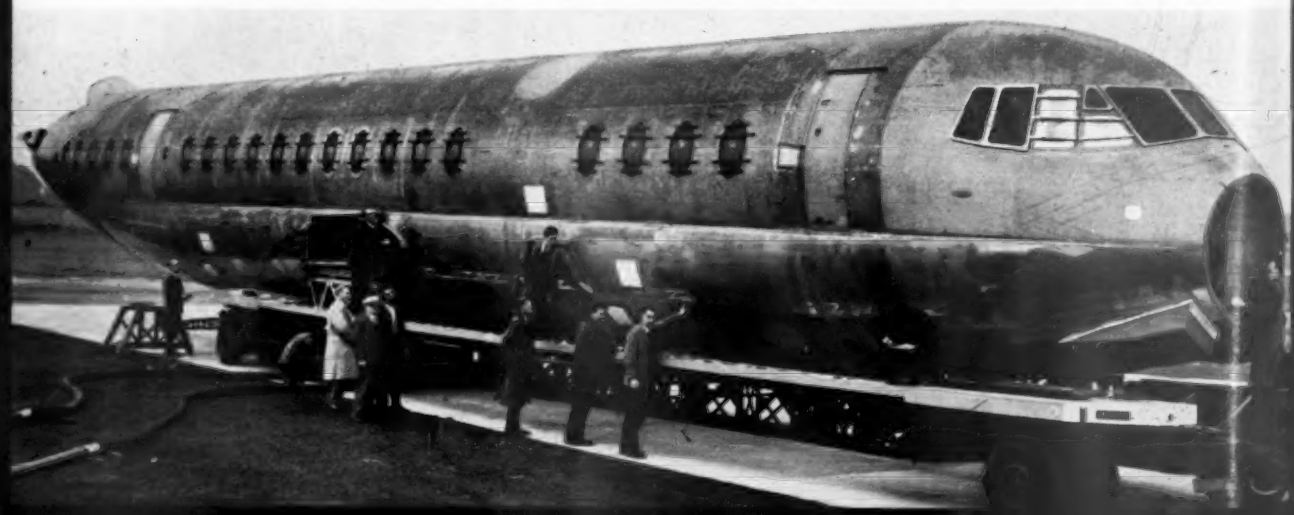
MR. GEOFFREY DE FREITAS, M.P., the Association's vice-president, quoted the best pre-War annual figure at 62,000 hours compared with today's 97,000 of which 90,000 was by A.B.A.C. clubs. However, our hours were only one-third of France's whose Government provided big subsidies. Here, where club finances were so finely balanced, the Government proposed abolishing the clubs' petrol tax rebate, a move which at best could only benefit the Treasury by some £32,000, but which in practice would probably decrease their income from this source because of reduced flying.

Mr. de Freitas, who in the Socialist Government was largely responsible for the introduction of the rebate, begged the Government to reconsider a decision which would help turn private flying into a rich man's sport. He pointed out that with fewer ex-R.A.F. aircrew to call upon, the airlines depended increasingly on private pilots for their recruiting. But for the A.B.A.C., private flying would be dead, for Government assistance would not have been obtained if standards, aimed at securing uniformity of flying training, had not been drawn up and maintained by the Association.

MR. GEORGE WARD, Secretary of State for Air, also spoke of pre-War club flying when the 12,870 club members included those who, like himself, belonged to as many as eight clubs. Today, when A.B.A.C. club membership embraced membership of all the other A.B.A.C. clubs, the figure of 15,000 members was a better and truer picture. He generously acknowledged the 1950 ground work put in by Mr. de Freitas in setting up the A.T.C. Flying Scholarship Training Scheme which the Air Ministry relied on to stimulate recruiting and regarded as a wise investment. Of the 2,000 scholarship cadets, over 700 had joined the R.A.F. on regular engagements. Annual cost of the scheme to the Ministry was £60,000 for 350 cadets.

Mr. Ward, after expressing the R.A.F.'s appreciation of the value of the A.B.A.C. appealed for all to help dispel the idea, held by many headmasters and parents (especially "Mums") that there was no future for a lad in the R.A.F. because "Push-

NEW TRANSPORT.—I.—The second Vanguard fuselage to come off the production line at Vickers' Weybridge works is being used for pressurization tests at differentials ranging from 2 to 7 p.s.i. The first Vanguard is expected to fly in mid-December.



NEW TRANSPORT.—2.—While deliveries of Comet 4s to B.O.A.C. continue principally from Chester, the six Comets for Aerolineas Argentinas are taking shape at Hatfield. Seen here in the erecting hall is the second of the batch, LV-PLO.

button" warfare would eliminate manned aircraft. The Sir James Grigg Committee's Report on Recruiting should lead to more recruits of higher quality. More R.A.F. Flying Clubs would be encouraged by his Ministry to form and he wanted to make more R.A.F. airfields available to private flyers for casual landings—but not too casual, he hoped.

MR. G. H. M. "EUSTACE" MILES, A.B.A.C. chairman, spoke of the protests over the closure of Croydon. "Too much, too late" was his theme and he commended those affected to take a new look at Biggin Hill where the Air Ministry are offering leases for longer terms than originally planned. He was assured by Basil Meads, representing the Kemsley Trust, that that benevolent body would also assist where it could.

Speaking of M.T.C.A.'s attitude to the clubs, he said that after getting little help or sense out of M.C.A., relations improved when the A.B.A.C. proved its value but in the last two years there had been a change for the worse in the atmosphere. The Minister, however, was now taking a personal interest and was setting up a Standing Joint Committee on Private Flying and Gliding. Mr. Miles hoped that the successors of Home Command, which was to be liquidated, would be as co-operative with the A.B.A.C. as were their predecessors.

He referred to a letter of his, published in THE AEROPLANE in 1955, which stressed the need for a secure future for commercial pilots. Now he had heard of some 170 of them becoming redundant. What clubs needed were more utilization, more aerodromes, new aeroplanes and pegged prices. The A.B.A.C. Council wanted improved facilities for club members and offered £10, £5 and £3 for the three best suggestions on "What should be done to make the Flying Club, Air Centre and Flying Group movement more interesting and of greater benefit to the members." Club members should post their ideas to the A.B.A.C. before November 30.

SIR GILMOUR JENKINS, Permanent Secretary, M.T.C.A., speaking in the absence of the Minister and the Under Secretary, was charmingly non-committal. The "change of atmosphere" complained of by Mr. Miles was imaginary. Flying clubs were up against the facts of life—the difficulty was persuading hard-headed people of the *monetary* value of private flying. The closure of Croydon was to be debated in the House during the week.

After the ABBE AMIARD, of the Fédération Aéronautique de l'Union Française, had made his customary amusing speech, defining "Progress" as "seven people in a four-seat aeroplane" and giving details of the new Jodel Mousquetaire, Mr. de Freitas presented the Alan Lennox-Boyd Trophy, for the most effiecient club, to Jimmy Denyer, manager of the Newcastle Municipal Flying School and Air Centre, who rated 71.1%; Southend scored 70.6%, Elstree 69.3%.—WREN.

A D.H.Ae.T.S.O.B.A. Occasion

ANECDOTES and reminiscences of another aeronautical era were produced in fine style in London last week by Sir Alan Cobham, K.B.E., A.F.C., F.R.Ae.S., who recalled some of the excitement and fun of flying in the pioneering days after the First World War. He was speaking as the guest of honour of the de Havilland Aeronautical Technical School Old Boys' Association at their eighth annual dinner at Simpsons in the Strand, at which nearly a hundred members and their guests were present to enjoy a notable occasion.

He was introduced by the Association's president, Mr. J. L. P. BRODIE, M.I.Mech.E., F.R.Ae.S., engineering director of the de Havilland Engine company, who spoke of the tremendous contribution Sir Alan had made to aviation. And he reminded him of some early events at Stag Lane aerodrome, of film carrying and film making.

SIR ALAN COBHAM had some nice things to say about the de Havilland technical school and the important part it has played in the country's aeronautical development. He recalled the company's beginnings and told a nice story of the acquisition and subsequent career of two War surplus D.H.9s, which he bought at Castle Bromwich for £10 and were later sold to Spain for £300. His account of their eventual arrival in Spain and their fate during the official ceremonial handing over was received with delight.

Sir Alan gave, too, an entertaining first-hand account of flying copies of the film of the 1922 Derby all round the country for showing in local cinemas on the evening of the race. He recalled the Plymouth-Belfast airmail service; the first flight of the D.H.34 and the notorious Stag Lane ditch; the D.H.54; and the Airspeed Ferry. And his story of the little D.H.53 and a flight to Brussels in it was a classic presented with characteristic Cobham gusto.

MR. J. M. RAMSDEN, the Association's chairman, proposed the Toast to the distinguished guests, many of whom were D.H.Ae.T.S. "Old Boys" in their own right. They include Mr and Mrs. R. E. Hardingham; Mr. and Mrs. R. H. Bound; Mr. and Mrs. M. G. Ash; Mr. and Mrs. Thurstan James. SIR VERNON BROWN, Kt., C.B., O.B.E., F.R.Ae.S., replied on behalf of the guests. And MR. D. G. BROWN proposed the health of the ladies.

Aerodynamics at Brussels

FORMERLY chief superintendent of the Royal Aircraft Establishment at Bedford, Professor L. H. G. Sterne, M.A., F.R.Ae.S., is now Director of the Training Centre for Experimental Aerodynamics at Rhode-Saint-Genèse, near Brussels.

Established two years ago, TCEA operates one-year post-graduate courses for aerodynamicists of NATO countries (see THE AEROPLANE for March 14). Professor Theodore von Kármán is chairman of the board of directors.

The new course of 20 students, which has just started work, includes students from the U.S.A. (three), Belgium (two), Greece (two), Italy (one), Holland (three), France (two), West Germany (four), Norway (one) and Great Britain (two). The British students are Mr. A. N. Dewar from the Royal College of Science and Technology, Glasgow, first holder of the Blackburn Scholarship, and Mr. P. J. Simpkins who took a Diploma in Advanced Technology at Northampton College in 1957.

An Eminent Meteorologist

AT the age of 90, Sir Gilbert Walker, C.S.I., F.R.S., died on November 4. Born in 1868, he was educated at St. Paul's School and Trinity College, Cambridge. Although his life was initially concerned with matters in the fields of dynamics and electromagnetism, he subsequently made extensive research into the subject of meteorology, and for 20 years was Director-General of Indian Observatories.

A.E.S. writes:—

Versatility was an outstanding characteristic of Sir Gilbert Walker. Who would expect a professional meteorologist to organize a scientific investigation into the power output of athletes' muscles, as he did?

Sir Gilbert made a reputation as an administrator during many years' directorship of the meteorological services in India. While there he undertook a scientific study of the soaring flight of vultures; later he had an opportunity of passing on this knowledge to the gliding community when, after returning to England to take up the post of professor of meteorology

at Imperial College, he joined the Council of the British Gliding Association during the first four years of its existence.

Sir Gilbert's connection with gliding started him off on a study of patterns of convection currents, which he produced on a model scale by blowing smoke into a shallow chamber with a heated metal bottom and a cooled glass top. On moving the glass to produce "wind shear," he observed the smoke to divide up into parallel rolls; and here, for the first time, was a plausible explanation of the "cloud streets" so familiar to glider pilots.

Discussing the Rotodyne

ALMOST to the day, a year's flight testing of the Fairey Rotodyne was marked on November 7 by the delivery to a joint meeting of the Royal Aeronautical Society and the Helicopter Association of Great Britain of a monumental paper by Dr. G. S. Hislop, chief aircraft engineer of the Fairey Aviation Co., Ltd. (see p. 727). In the presence of distinguished visitors from the Services and from aircraft operating companies in the United States it had to be admitted that what a Ministry speaker described as "one of the World's most remarkable aircraft" still needs more development.

MR. R. A. SHAW, assistant director, aircraft research, at the Ministry of Supply, expressed his admiration for the way in which the problems implicit in the design of a VTOL aircraft had been solved in the Rotodyne, but went on to say that the conception of the aircraft was not enough; much work was needed on the ground organization required by VTOL aircraft.

MR. B. S. SHENSTONE, chief engineer of British European Airways, said it was the most economical rotary-wing aircraft in the World and the only one which carried enough passengers to suit B.E.A.'s traffic pattern. He mentioned the difficulties of its noise and operating cost. One could not appreciate the noise when given in terms of decibels—"hearing is believing." Fairey's had produced the wrong level of noise quickly, and should be given time to produce the right level.

PROF. J. A. J. BENNETT, professor of aerodynamics at the College of Aeronautics, one of the two original patent holders of the Rotodyne idea (the other, Capt. A. G. Forsyth, was also present), congratulated Dr. Hislop on bringing the Rotodyne to fruition after a decade of engineering development.

MR. W. TYE, chief technical officer of the Air Registration Board, spoke of the relatively poor reliability record of helicopters compared with fixed-wing aircraft. Helicopter enthusiasts tended to regard the A.R.B. as a stodgy body because of its concern for proven helicopter reliability, but passengers had a right to expect the same safety when travelling by helicopter as by fixed-wing aircraft. He hoped that the ship would not be spoiled for a ha'p'orth of tar—or the odd million pounds needed to turn the Rotodyne into a proper airline vehicle.

MR. P. G. MASEFIELD, managing director of Bristol Aircraft, Ltd., said that Fairey's had to find a fairy godmother to provide money for Rotodyne development. He hoped to see some money come into the coffers of Fairey's and of other helicopter manufacturers. In his view the use of test rigs (as described by Dr. Hislop) was one of the more important trends of our times.

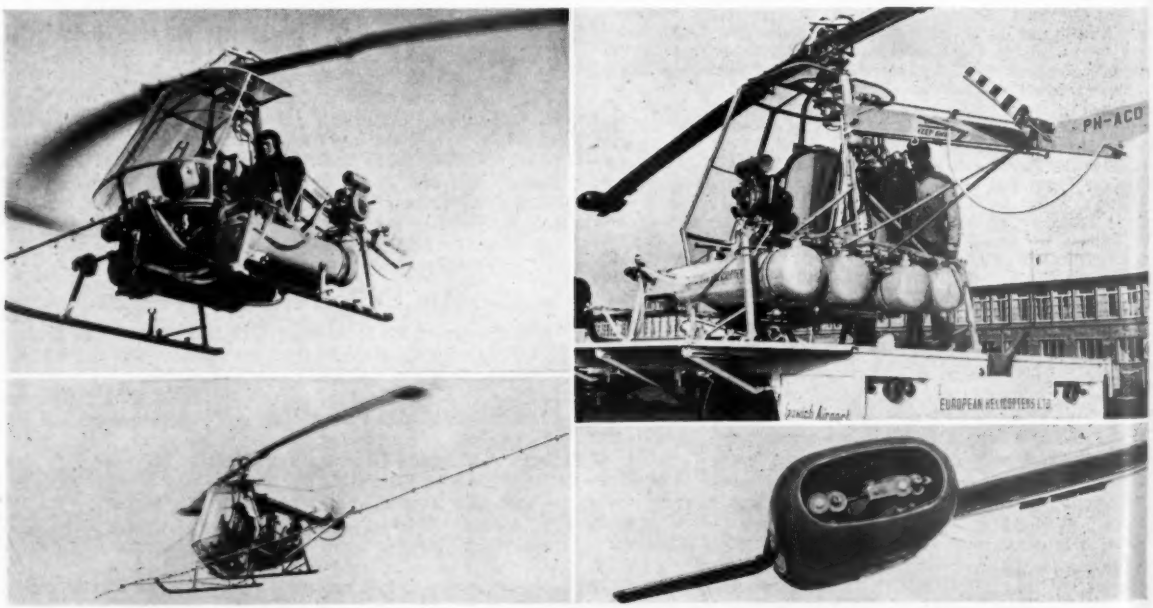
MR. A. H. MILWARD, chief executive of B.E.A., said that the noise and operating cost of the Rotodyne were important. It must be quiet enough to operate high-frequency services into city centres. He said the airline recession had proved the susceptibility of traffic to fares and cited the new cheap B.E.A. service to Glasgow. The cost to the passenger was only 2½d. per mile; as a result there had been 450 applications for seats on the first week-end of the service.

Independent Results

LITTLE real progress has been made by the member companies of the British Independent Air Transport Association in the 1957/58 year, according to the B.I.A.T.A. annual report. This report, published on the occasion of the annual dinner held in London on November 12, shows a limited increase in several directions, but often this increase has been less than expected. The overall picture remains much the same as that of a year ago—with the independent companies contributing some 25% of the total U.K. air effort but unable to consolidate or expand because of the limitations imposed on their activities both by economic conditions and by Government regulations.

We propose to deal with the report in greater detail next week. The following figures are sufficient to indicate the overall trend. In the year ended June 30, 1958, B.I.A.T.A. carriers flew 1,366,755 passengers (of which 10% were on trooping flights, 10% on inclusive tours, 22% on charter and contract flying and 58% on general scheduled services). Passenger-miles performed totalled 1,117 million (of which 66% were on trooping, 8% on inclusive tours, 10% on charter and contract and 16% on general scheduled services).

Total capacity offered on scheduled operations increased by 20% but load ton-miles by only 14%, lessening the overall load factor from 62.2% to 59.9%. In charter and contract freighting load ton-miles increased by 80% although the actual tonnage lifted declined; there was also a decline in the number of charter passengers carried.



Photographs copyright "The Aeroplane"

RURAL ROTORCRAFT.—Crop-dusting by the N.H.I. Kolibrie H-3 ramjet-powered helicopter was demonstrated at Ipswich on November 10 by the U.K. agents, European Helicopters, Ltd. Remarkable stability and rapid manœuvrability were displayed by Rene van de Harten, chief test pilot of N.H.I., who also proved the Kolibrie's ability to fly on one ramjet. Basic price is £8,050 or £13,500 with trailer and full agricultural equipment.

Air Commodore Banks Supported at Derby

LECTURES at branches of the Royal Aeronautical Society are likely to be followed by interesting discussions. It seems that the informal atmosphere encourages speakers to express opinions and convictions.

Having read Air Cdre. F. R. Banks' paper on "The Present and The Future" (of the British aircraft industry) while travelling up to Derby, we guessed that a worthwhile evening was in the offing. And we were not disappointed by the outcome. Extracts from the paper, the third Sir Henry Royce memorial lecture, were published in our issue for November 7.

A full-house audience boded well for discussion time, particularly since it contained an unexpectedly large number of the industry's "top brass," many of whom had little hesitation in speaking their minds. As this report shows, expression of opinion was forthright.

Opening the discussion, Mr. A. A. LOMBARD (director of engineering, aero-engines, Rolls-Royce, Ltd.) agreed with the emphasis on the important rôle played by the aero-engine part of the aircraft industry. It was vital that the civil aviation industry should receive sufficient official support in the United Kingdom. Otherwise, the enforced business of "going it alone" resulted in too conservative an approach to design because of the serious risks of "sticking one's neck out too far."

There was a great deal of design ingenuity in this country, but to compete successfully in international markets a stable industry was essential. Lack of official direction was very bad. Requirements must be anticipated, whether for civil or military needs, since there would be no chance to meet last-minute requirements which could only be met by buying from abroad. This aspect of requirements must be cleared up in time for the next phase of aircraft development—whether for VTOL, supersonic civil aircraft or whatever was to come. Some definite lead must be given.

Mr. Lombard was confident of weathering the present storm, with the help of Government backing for research and development. It was important to realize that our export successes (of all engineering products) were in part due to the good name of our aircraft industry abroad.

SIR GEORGE EDWARDS (managing director of Vickers-Armstrongs (Aircraft), Ltd.) made the interesting observation that the two other big countries in the aircraft business both gave Government support to their industries whereas we for some odd reason did not!

So far as a supersonic airliner was concerned, the British companies capable of developing one would probably be out of business before they could get around to producing one. Such a project was quite impossible without a comparable military type backing it.

Sir George was blunt in not feeling so optimistic as Mr. Lombard about the future and the Government "seeing the light." "Truth," he said, "comes out too late more often than not. We are in for a shocking time!"

There would be no money to spare for astronautics.

AIR CDRE. BANKS suggested that R.A.F. Transport Command might have the "luxury" of a supersonic transport as the means of getting a civil supersonic aircraft. Commercial aircraft at least should be supported officially, if not, the aero-engine industry would fail. Some work on astronautics ought to be done, even if it was a small amount.

MR. A. V. CLEAVER (chief engineer, rocket propulsion, Rolls-Royce, Ltd.) was sure that the Government did not appreciate the various aspects raised. There were two main points about the future of the British industry. The first was the matter of "dither"—while we could not afford to do everything, we must decide on one or two things and not fall into the trap of starting something off, stopping it before completion, repeating the process and finishing up with nothing.

An example of this was a company [A. V. Roe and Co., Ltd.—ED.] which had first worked on a supersonic interceptor and nearly finished it when it was cancelled, and had then embarked on development of a supersonic bomber which was later also cancelled. Engineering and scientific effort needed continuity, it could not be turned on and off like a tap. Some end-product was essential.

The second main point was that developments in the aircraft industry, such as new materials and techniques, had an intangible but direct benefit to other industries which also gained prestige from achievements of the British aircraft industry, the advances in nuclear reactor design and so on.

Astronautics work would be well worth while. There was no doubt that applications of its technology would come into use within 10 to 20 years. If Britain did not participate, she would be shut-out from the new technology and lose prestige. One day, many thousands would be employed in the astronautics business although this was as hard to visualize as the present aircraft industry would have been in the day of Sir Henry Royce.

A less extreme example of this was the supersonic transport. If we did not produce one, we would be excluded from an important field of design and experience.

AIR CDRE. BANKS was sure of the need to convince both the Cabinet and the Treasury of the true state of affairs. Even now, the mistakes which had been made in the aircraft industry were being repeated with guided weapons. Some evidently less-successful weapons were still being developed.

Enough brain power was available to cope with astronautics and with a new strategic transport instead of buying an American one. Since the War, the procurement and requirements department had been "dreadfully weak."

AIR CHIEF MARSHAL HON. SIR RALPH COCHRANE felt that the lecturer had been rather gloomy in his assessment of the situation. For one thing, the European Common Market offered good possibilities. In the VTOL concept of Dr. A. A. Griffiths the surface had so far only been scratched. He was sure there was still a future for aviation. There had been crises in past times, too.

AIR CDRE. BANKS remained adamant and pointed out that the cost of technical advances was vastly more than in years gone by. The main problem was the lack of firm requirements.

MR. F. M. OWNER clearly felt very strongly. He said that any nation which had chosen luxuries rather than defence had gone down the drain. We needed the modern equivalent of Drake's fire ships but nowadays this would cost "a devil of a lot of money." Development must be done energetically or not started. If there was no money forthcoming there would be no industry.

MR. N. E. ROWE (technical director, Blackburn and General Aircraft, Ltd.) thought that a mean path was possible. More and more manned aircraft would be needed for civil and military transport. Air transport was steadily advancing and a great future lay in the subsonic regime where a real service to communities could be provided. "Choose the right things to do," said Mr. Rowe, "and there is a good future for us."

AIR CDRE. BANKS did not disagree. There was indeed a great field for the high-subsonic-speed aeroplane offering cheap fares and a short transit time for passengers not requiring a steward service. The weakness of the Bristol Brabazon concept was now evident because its complement of 60 passengers was taken by a Viscount-size of aeroplane.—D.G.

Celebration at Croydon

ABOUT 200 members of the Surrey Flying Club and their guests assembled at the "Greyhound" in Croydon on October 31 for their annual dinner and dance. Opportunity was taken of the occasion to present prizes won during the year.

MR. K. M. FREEMAN, the chairman, welcomed the guests and proposed their health. During his speech he said that in 1957-58 the club had flown a total of 3,750 hr.; that the fleet now consisted of nine aircraft—five Tiger Moths, a Chipmunk, a Hornet Moth, a Leopard Moth and a Prentice. The club is still the only one so far operating a Prentice.

In the course of remarks about the running of the club the chairman was pleased to acknowledge the efforts made by Mr. John Donovan in organizing the various club rallies.

MR. DUNCAN LUSH, vice-president of the club, replied. He paid tributes to the former chairman, Mr. C. A. Nepean Bishop; to Mr. Peter Chinn, the present C.F.I., and to Mr. "Tiny" Marshall, assistant instructor.

About the fate of Croydon, Mr. Lush said that the club now had the same hope for the future as was expressed at the first club meeting, and that whether they go to Biggin Hill or elsewhere a happy solution would be found.

Mrs. Lush then presented the prizes, firstly the Harris Trophy, for navigation, to Mr. John Donovan, and the Thurstan Trophy, for the best all-round progress by a member, to Miss Mary Privett. It is the first time that a woman has won this trophy.

News of Aircraft, Engines and Missiles

UNSCORCHED EARTH.—At Belfast recently, Mr. Tom Brooke-Smith, Shorts' chief test pilot, landed the SC.1 VTOL aircraft on a soft football pitch to find out what would happen to the ground after hovering at 20 ft. above it for 5 min. Examination of the surface of the field later showed that it was undisturbed except for slight scorching of the grass.

TWIN PIONEER ORDERS.—A Scottish Aviation Twin Pioneer in air survey configuration has been ordered by the Swiss Knietftechnische Abteilung. About 60 Twin Pioneers have now been ordered, including 32 for the R.A.F., and another small R.A.F. order is expected in the near future. The first Twin Pioneer with R-1340 Wasp engines for Philippine Airlines is now in flight test, and the 600 b.h.p. Leonides 530 will be available in Twin Pioneers next year.

CANBERRA FLIGHT.—On November 4 a Canberra flew the 2,210 miles from Gander, Newfoundland, to Warton, Lancs, in 3 hr. 48 min., an average speed of 585 m.p.h. It was the first export Canberra delivered to the Venezuelan A.F. in 1953 and has returned to the English Electric Co. for a major overhaul.

MOON ROCKET FAILS.—The third U.S.A.F. Moon-probe attempt failed on November 8 when the third stage of the vehicle failed to ignite. Two Moon-probe launchings are now to be made by the U.S. Army with a vehicle based on the Jupiter IRBM.

FRENCH EXECUTIVE.—Sud-Aviation have designed a turboprop executive and light transport aircraft known as the S.E.118 Diplomate. Powered by two Turboméca Bastan turboprops, it will seat 8-10 passengers in the circular-section, pressurized fuselage. The Diplomate is designed to fly a 1,250-mile stage, with reserves, at about 20,000 ft. and 270 knots.

BOEING SUPERSONICS. — The president of the Boeing Airplane Company, Mr. William M. Allen, went on record last month with the statement that his company has, like others, been working on the preliminary design of a supersonic (1,200-1,400 m.p.h.) transport. Such an aircraft could be put into the air within the next five or six years, but he did not think that the airline industry would be ready for this next advance for 10-15 years.

INDIAN LIGHTWEIGHT.—Pushpak is the name of a new ultra-light aircraft produced by the Hindustan Aircraft Factory of Bangalore. It is for use by both civil and military organizations for training, communications and liaison and as an AOP aircraft.

BASTAN TEST-BED.—The Beechcraft BD.18 fitted with two Turboméca Bastan turboprops by SFERMA has achieved more than 275 m.p.h.

SIKORSKY REDUCTION.—Declining production schedules will force the Sikorsky Aircraft Division of the United Aircraft Corpn. to reduce its work force by about 1,100 employees between now and April 1, 1959.

HELICOPTERS DOWN UNDER.—American interests are financing a company to build helicopters in Australia. Known as K.B. Brantley Helicopters (Australia) Pty., Ltd., the company will have two Australian directors; a factory is to be built at either Brisbane, Sydney or Melbourne. It is hoped to market the first helicopters early next year.

NEW GRUMMAN TYPES.—Two new types being developed by the Grumman Aircraft Corpn. are the A2F-1 and the W2F. Described as an all-weather aircraft, the A2F-1 is for land- or carrier-based operations in localized wars and for low-level attack. It has STOL capabilities and can carry a variety of weapons. The W2F is a more advanced and larger version of the WF-2.

NORTH AMERICAN NEWS.—The U.S.A.F. has placed an order for the Sabreliner (two G.E. J85 turbojets) now designated T-39. Super Sabre production is to end next year.

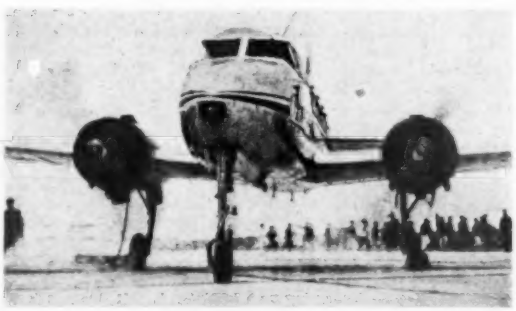
LOCKHEED PROPOSAL.—Powered by two Lycoming T-53 turboprops, this Lockheed VTOL aircraft is of the tilt-wing deflected slipstream type. It is a two-seater designated the CL-379.

JINDIVIK ORDER.—An additional 40 Jindivik target aircraft have been ordered for use in the U.K.; the order, including spares, is worth £A1 million to the Australian aircraft industry.

EQUIPMENT IN SPACE. — A specially designed Flight Director-Attitude Indicator for the North American X-15 space research vehicle (see pages 730 to 733 of this issue) was recently developed by the Lear company of America. The company has also received a contract for a study of a space vehicle crew capsule for the Wright Air Development Centre

RYAN DEVELOPMENT. — A new version of the Ryan Firebee remote-controlled jet target drone, designated the Q-2C, is being developed for the U.S.A.F. It is expected to achieve more than 500 knots at above 50,000 ft., and is powered by a 1,700-lb. thrust Continental J69-T-29.

DC-9 STUDIES. — According to *Aviation Daily* the Douglas DC-9 project is currently seen as a 125,000-lb. transport with a range of 2,000 miles carrying 72 passengers. Both twin- and four-engine designs are being studied. Now that commercial aircraft production has ended at Santa Monica, Douglas would like to see the DC-9 in production if airline backing can be obtained.



PEKING PRODUCT.—First indigenous product of the Communist Chinese aircraft industry is the Peking No. 1 light transport, which is intended to convey eight passengers over ranges of 600 miles at speeds of around 180 m.p.h.

MYSTERY SOLVED.—The wreckage of an aircraft found recently in the Australian Alps in southern N.S.W. is reported to be that of the "Southern Cloud," a Fokker F.VIIB/3m of Australian National Airways which was lost on a flight from Sydney to Melbourne in March, 1931. It appears that the aircraft flew into dense timber near the top of a 5,000-ft. ridge in bad visibility, killing the six passengers and crew of two. The disappearance of this aircraft caused one of the greatest air searches ever known in Australia.

ommercial Aviation Affairs

B.E.A. GO AHEAD.—On November 11, B.E.A. formally announced that they would extend their facilities for "all in" holidays next year. Subject to the approval of the foreign governments concerned, B.E.A. will offer cheaper-than-ever wholesale rates to travel agents for seats on Viscount night services, mostly mid-week, to 15 holiday centres in Spain, Italy, Switzerland and France. Some implications of the scheme, which is expected to reduce the total cost of inclusive tours by 3-10% in the 1959 season, were discussed in our previous issue on page 676.

VENEZUELAN PROSPECT. — Dr. Oscar Zuloaga, Venezuelan Minister of Aviation, is reported to have said in Caracas last week that he would recommend to the Government the purchase of three Comets and several Britannias. He hoped the recommendation would be accepted by the new Government to be elected on December 7.

F-27B DELIVERED.—Fairchild have delivered their first F-27B combination passenger/cargo transport to Northern Consolidated Airlines, which has three on order. This version has a new floor with four tracks for seats or cargo tie-down, and a large freight-loading door. A similar version ordered by the Royal Netherlands Air Force will be built by Fokker as the Freightship.

FROM EAST GERMANY.—This new picture of the Baade 152 clearly shows the bicycle undercarriage, with outriggers, used on the prototype. Production models, expected to fly next year, will have a more conventional arrangement.

P.A.A. ON THE BALTIC.—Pan American World Airways has joined the Baltic Exchange Air Market, and has appointed James Burness (Travel) Ltd. to act as sole brokers.

Tu-104 NOISE REDUCTION.—Answering a question in the House, Mr. Neave said last week that the Soviet authorities have recently provided information on techniques of operation which they claimed would reduce the noise of the Tu-104 to that of contemporary piston-engined aircraft. The Ministry was now considering the effectiveness of these techniques. They were anxious to see the service to Moscow start as soon as possible but did not think the Tu-104 would be able to meet conditions laid down for the Boeing 707 and Comet.

MISSING MARINER.—A Martin Mariner flown by Artop on the route from Lisbon to Madeira was reported missing after a forced landing about an hour after taking off from Lisbon on November 9. The aircraft had 36 persons on board and was commanded by Capt. H. F. Broadbent. Artop (Aero-Topografica Ltda.), with headquarters in Lisbon, began a thrice-weekly service to Madeira following the cessation of Aquila Airways service on September 30.

ews About People

TRANSPORT LECTURE. — The senior pilot of B.E.A.'s Viscount Flight, Capt. R. Ellis is to give a lecture, "Air Traffic Control—a day in the life of a civil air pilot," to the Northern Ireland section of the Institute of Transport on November 20. The meeting will be held at 21 Linenhall Street, Belfast, at 18.00 hrs.

D.H. CHANGES.—The following new appointments were recently made by The de Havilland Aircraft Co., Ltd.: Mr. F. H. M. Lloyd, A.F.R.Ae.S., hitherto commercial sales manager and contracts manager, is now sales manager; Mr. J. A. Grace becomes commercial manager and continues to be responsible for the spares department with Mr. N. G. E. Dunlop, C.A., as his assistant; Mr. J. C. Corby, O.B.E., M.A., formerly general manager of the company's Chester factory, is assistant sales manager; Mr. P. F. L. Hall, B.E.(N.Z.), F.R.Ae.S., D.F.C., becomes technical sales manager; Mr. P. P. Hearle and Mr. H. Shaw are now assistants to the sales manager on general duties and airline liaison respectively. Appointed assistant to the managing director is Mr. P. G. Lucas, G.M., F.R.Ae.S.

PRACTICAL EXPERIENCE. — Seventy-year-old M. Lemercier, director of the Société Générale de Parachutes, of Selles-sur-Cher, recently made the first test jump with a new parachute of his own design. This French company is an associate of Irving Air Chute of Great Britain, Ltd., and makes parachutes of Irvin design under licence.

PROPS SECRETARY.—Mr. J. D. Crane, A.C.A., has been appointed company secretary of de Havilland Propellers, Ltd. He takes over from Mr. A. S. Wheate, who remains financial director.

AER LINGUS REORGANIZATION.—Capt. J. C. Kelly-Rogers has now assumed more general management duties within Aer Lingus and the job of assistant general manager (technical) has been taken over by Capt. W. J. Scott, previously operations manager. Other new assistant general managers are Mr. James Gorman (secretary), Mr. P. J. Brennan (commercial), and Mr. M. J. Gargan (administration). Mr. James Moran is appointed financial controller of the company.

VTOL PEOPLE.—At the Fairey Rotodyne lecture, reported on pages 727-8, Dr. G. S. Hislop (centre, front row) gave full credit to this team of people involved in development of the VTOL airliner.

MORE NEWS ITEMS ARE ON P. 729.

Air Transport

Atlantic Jet Services

TODAY, November 14, B.O.A.C. was to introduce daily service by Comet between London and New York. The Corporation flew the World's first scheduled jet service in each direction over the North Atlantic on October 4, but this weekly service had to be suspended after a second service in each direction because of the strike of engineers at London Airport. Since the strike was settled, B.O.A.C. has kept its four Comet 4s fully occupied in crew training and today's service marks the resumption of Comets on the Atlantic. At present the Corporation has seven fully trained crews. The fifth Comet, G-APDD, began its flight trials at Hatfield on November 5.

The daily Comet flight leaves London at 10.15 hrs. G.M.T. and arrives in New York at 15.45 hrs. local. In the reverse direction, times are 21.30 hrs. from New York and 09.15 hrs. in London. The aircraft are arranged to accommodate 32 first-class and 16 de luxe-class passengers.

The first Pan-American service from London and New York by Boeing 707-120 is to be operated on November 17, following the arrival of the first service from New York at 21.35 hrs. G.M.T. on November 16. As a result of the dispute with A.L.P.A. discussed below (" Show-down or Shut-down? "), however, Pan American has had to reduce the frequency of this service and up to the end of this month will fly only seven round trips in 14 days. The aircraft are arranged to carry 68 economy-class and 42 first-class passengers.

Scheduled Boeing service between New York and Paris began on October 26 and is continuing on a daily basis. On November 9, this service was extended to Rome, following a reversal of the earlier Italian Government demand for a surcharge on jet service.

Show-down or Shut-down?

AMERICAN domestic trunk and international airlines are going through a particularly difficult period of labour relations, at a time when the large-scale introduction of new equipment calls for maximum co-operation between all levels of management, staff and labour. Up to the time of going to press, no solution seemed to be in view in either of two major airline disputes—one with the International Association of Machinists involving mechanics, and another with the Air Line Pilots Association concerning jet crews. In both disputes, matters of principle are involved, in addition to disagreement over rates of pay.

A mutual assistance pact between six major airlines—briefly mentioned in our October 31 issue—has been concluded in order to meet the " threat of extreme and unreasonable demands made by representatives of certain of the classes and craft of employees," of which the present dispute with the I.A.M. is given as an example. Under the terms of this pact—which is effective as from October 20 unless declared illegal by the C.A.B.—any of the six airlines involved (American, Capital, Eastern, P.A.A., T.W.A. and United) which become inactive through strike action will receive from the other airlines the increased revenues which they receive as a result of the strike. The agreement will be in effect for one year and will be of immediate benefit to Capital, whose I.A.M. mechanics have been on strike since October 17 in support of a demand for a 42 cents per hour rise. Strike action by I.A.M. against Eastern and T.W.A. is also threatened.

The presidents of both A.L.P.A. and the Flight Engineers International Association have threatened to " unite labour in the airline industry " to fight what is termed " union breaking " if the C.A.B. approves the airlines' pact.

Meanwhile, a more fundamental issue is at stake in the dispute between A.L.P.A. and the airlines in respect of jet transport operations, mentioned in THE AEROPLANE for October 31, page 646. The union—which concludes contracts on behalf of the pilots employed by each airline—has asked for pay increases of up to about $20,000 a year for senior captains flying jets on international routes, over the existing top salaries of about $25,000 a year, with smaller increases for domestic routes and junior captains. But the crux of the matter is the controversial " third man " issue: A.L.P.A. is insisting that the third man in the cockpit should be a qualified pilot rather than a flight-engineer as at present. No airline has agreed to this; indeed, Pan American and American both have signed contracts with the engineers giving them the third place.

Pan American is flying its Boeing 707 service to Paris—and, now, Rome—with supervisory personnel (employed direct and not through A.L.P.A.) but the daily service to London, due to open on November 16, will have to be restricted, as noted above. Pan American's existing contract with A.L.P.A., covering piston-engined aircraft, expires on December 31. After that date, the pilots may continue to fly without a contract—as American Airlines' pilots have been for more than a year past—but the situation would then be a delicate one, in which the pilots could legally withhold their labour at any time.

DOWNTOWN HELIPORT.—In addition to providing a heliport on the Hudson River close to New York's Manhattan district, the Port of New York Authority maintains its own private heliport on top of its office block. Just discernible in this picture is the Port Authority's Bell 47J taking off for a sortie.

Long-range Boeings

THE first of the Boeing 707-436s for B.O.A.C. is expected to fly in February and to be delivered in December next year. This aircraft is being made in advance of the remainder of the order and will be used for certification flying with the Rolls-Royce Conways, the first of which recently arrived at Renton by air.

The Corporation's 707s will be certificated at a gross weight of 312,000 lb. (or 316,000 lb. for taxi-out)—a weight which is structurally permissible for all the 320s and 420s when these have a redesigned undercarriage. The new gear involves an additional structure weight of only 400 lb., and B.O.A.C. considers that it will be worth while to carry this little load around for the first period of operation in expectation of a developed thrust from the Conways which will eventually permit the higher weight to be used. The starting thrust is likely to be

(*Continued on page* 717)

Nearing completion in the final assembly building at San Diego, where it will soon be joined by other examples, is the first Convair 880. Swissair recently ordered five Convair 880's and have announced plans to use them in pool with SAS.

(*Continued from page* 716)

about 16,500 lb.—rising to 18,500 lb. or more per engine and maintained with water injection. The higher take-off weight will allow an increase in stage-distance of about 500 n. miles or in payload of 10,000-12,000 lb.

For obvious reasons, B.O.A.C.'s 707s will be equipped largely to American standards, but any British ancillaries which offer positive advantages will be installed. For instance, the basic autopilot-navigation equipment will be of U.S. manufacture—including a Bendix PB 20D autopilot, integrated instrument system and Polar Path compass and Kollsman air data system—but space provision is being made for dual Marconi 2300 Doppler navigator equipment, which is considered to be well in advance of comparable U.S. Dopplers, and a number of other navigational items are to be British. The weather-mapping radar will be Ekco E160 and the dual ADFs will be Marconi. Radar transponder equipment will also be installed, and this will be by Cossor.

Present furnishing plans for the 436s involve variations of three basic layouts. These are for 66 de luxe sleeper passengers, 117 normal first-class, and 174/180 tourist passengers.

The first -321 long-range 707 for Pan American is well advanced and is due to fly in December. It will be put through a complete testing programme and the interior of the fuselage is already being fitted up with a very complete series of automatic recording systems and ballast tanks.

The work will be considerably aided by Boeing's data processing department in the flight test centre which can handle in three days the computations which, completed manually, would involve weeks or months of work. The system can deal with 100,000 points per day. One advantage of a system which is designed to deal with all the recorded information all the time is that, though a great deal of unwanted information is processed in the natural course of events, this information provides a permanent record. When and if, on a future test, any particular trouble crops up, the history of the data can be traced back and re-testing avoided.

Swedish Enterprise

ONE of the newer names to be found among the 300 or so companies listed in our guide to the World's airlines published last week is that of Linjeflyg AB. The operator of Sweden's domestic scheduled air services has been in existence now for 18 months or so, but its forbear has a history going back to 1950.

In that year, a charter company by the name of Airtaco AB was formed in Stockholm, with the principal task of carrying evening newspapers. Avro Anson 1s were used, and passengers were carried on the return flights from various parts of Sweden. The company obtained a contract to carry *Expressen*, the evening paper published by *Dagens Nyheter*—Sweden's most important daily—and the business expanded steadily. As the newspaper routes were extended to remoter parts of Sweden, larger aircraft were acquired—Avro XIXs, then various Lockheed types, including the 12A, the Hudson, the 14H and the Lodestar. A DC-3 was bought in 1955 and two more of this type in 1956.

While the expansion was going on, *Dagens Nyheter* obtained control of the company, but this did not stop Airtaco taking over the job of carrying *Aftonbladet*, the evening paper published by *Stockholms-Tidningen*.

During 1956, SAS, the operator of Sweden's international routes, was criticized for its domestic service policy in Switzerland. Only three domestic trunk routes were flown by SAS, which had neither the equipment nor the desire to operate a large local network. When negotiations began with various Swedish independent operators to take over this responsibility, it quickly became clear that Airtaco alone had the basis of the organization required.

Under the auspices of the Royal Swedish Board of Civil Aviation, therefore, SAS, *Dagens Nyheter* and *Stockholms-Tidningen* concluded an agreement to set up a new limited company in succession to Airtaco. Effective on April 2, 1957, this company took the name Linjeflyg AB; SAS held 50% of the shares, *Dagens Nyheter* 40% and *Stockholms-Tidningen* 10%. As part of the agreement, SAS added six DC-3s, four Lodestars and one Lockheed 12A.

Initially, Linjeflyg continued to fly the six routes which Airtaco had originated, radiating out from Stockholm to Rinkaby, Malmö, Sundsvall, Nordmaling, Jönköping, Karlstad, Linköping and Kronobergshed. Later, services to Kalmar and Visby were opened, and this year the network has been further extended to serve Ostersund, Kallinge, and Halmstad. By the middle of this year, the unduplicated route mileage was 2,075.

The fleet has now been stabilized at 10 DC-3s and four Lodestars, the latter being used for the newspaper services and general charter flying. The company employs 32 captains, 31 first officers—and 15 stewardesses. Chairman of the Linjeflyg board is Ake Rusck, the president of SAS, while the company's president is Sven Ostling. Other senior executives are: technical and operations manager, Ake Weimar; manager, traffic and sales, Anders Ericsson; manager, flight operations, Torvald Andersson and commercial manager, C. O. Munkberg.

A typical scene at an airfield on Linjeflyg's newspaper transportation routes, as newspapers leave and passengers arrive.

To Prague by Tu-104A

WHILE the re-introduction of the Comet into airline service and the arrival of the first Boeing 707s is causing some excitement in the West, it is salutary to keep in mind that the Russians have now been operating jet transports over a wide route network for more than two years. Although unspectacular in design, the Tu-104, which was the first Soviet jet transport, has apparently proved quite reliable and reasonably economical, and sufficient have now been built for operation by other countries in the Eastern bloc.

The first of these is Czechoslovakia, and C.S.A., the Czech national airline, has been flying three Tu-104s on European routes since the end of 1957. To be precise, the C.S.A. aircraft are in fact Tu-104As, which differ from the original types in having tourist accommodation in two cabins, separated by a galley, for 70 passengers; a payload increase of 6,170 lb. to a maximum of 19,800 lb.; and other internal modifications.

Some impressions gained during a recent scheduled flight on the C.S.A. route from Brussels to Prague by Tu-104A are recorded here to augment the more lengthy account of a demonstration trip at London Airport, described in THE AEROPLANE of April 4, 1958.

One's first impression on entering the rear cabin of C.S.A.'s Tu-104A is that the furnishings in no way resemble the rather baroque style adopted in earlier Soviet aircraft of this type, and in fact the fittings are almost severe in their practicality. The seats—arranged three abreast to starboard and in pairs to port—are upholstered in grey corduroy-type material, with white linen covers to the head-rests, and the ceiling is also white. Rather antiquated-looking bowl lighting occupies the centre of the cabin ceiling, and large net luggage racks run along each side of the fuselage. Each row of seats is opposite a window, which, as one would expect, is fairly small.

From the rear of the cabin, sitting next to a window, it was possible to see almost the entire swept wing, including, by judicious neck-stretching, the top of the jet-pipe outlet. As the 19,000 lb. thrust Mikulin-Zubets AM-3M turbojets woke into softly rumbling life and the Tu-104A taxied swiftly away from the sprawling new terminal building at Brussels, one next became conscious of festoons of rubber tubing extending from junction boxes on the cabin walls to pockets in the back of each seat, where bladder-type emergency oxygen masks are stowed. They are considerably more obtrusive than the "pop-out" type hidden in the luggage racks of the Comet and Boeing 707.

Take-off, with seat-belts tight, was accompanied by a shattering roar as the two big axial turbojets spun up to their maximum 4,700 r.p.m., but much of the sound was soon left behind as we moved rapidly forward. From personal experience, however, I would say that the acceleration was considerably less than in the Comet 2, which again is what one would expect from the substantially heavier (164,244 lb.) Tu-104A.

With the area-increasing slotted flaps extended on each side of the large undercarriage stowage pod, the take-off run took about 35 sec., after which a shallow climb began as the wheels of the bogie undercarriage could be seen, still spinning, retracting slowly into their nacelles. One of the modifications in the Tu-104A was the addition of a second hydraulic pump on the starboard engine to halve the undercarriage retraction and extension times, but these still remain about 25 and 30 sec., respectively.

Cruising at about 30,000 ft. and 480 m.p.h. in cloudless skies over the Rhine, the Tu-104A was smooth and relatively quiet (except at the extreme rear), although there was a slight out-of-synchronization beat in the steady roar of the turbines, and a disconcerting change of engine note at one stage half-way through the flight. Vapour trails arced in the deep blue above us, and a blue-nosed T-33 flashed by a few feet below in the opposite direction as a reminder of the military playground over which we flew. It is highly probable that neither pilot saw the other, at our 900 m.p.h. closing speed, but we had a good view, far below, of a big military airstrip near Koblenz from which the jet may well have come. Aircraft were clearly visible on its single runway, which makes one wonder why the Russians should bother with an official mutual air inspection plan.

Three young (and rather robust) stewardesses served breakfast, including beer, during the flight, and although the aircraft was perhaps only half full, they were hard put to clear away before the Tu-104A began a rapid descent towards Prague. This was achieved quite smoothly despite the absence of air brakes, and a straight-in approach was made to Ruzyné, with our swept-wing shadow racing over the ground at 180 m.p.h. to meet us. Power was taken off at some distance from the runway threshold, and a slightly asymmetric arrival at about 140 m.p.h. was followed by hard braking for a commendably short landing run. The 434 miles between Brussels and Prague had been covered in exactly one hour.—J.E.F.

Photographs copyright "The Aeroplane"

CZECH' RIDE.—Below, one of the C.S.A.'s three Tupolev Tu-104As seen at Brussels before the flight described above. Alongside is shown the interior of the rear cabin, looking aft.

The Fighting Services

Air Member for Personnel

AIR MARSHAL SIR HUBERT L. PATCH, K.C.B., C.B.E., who has been Commander-in-Chief, Middle East Air Force, since September, 1956, has been appointed Air Member for Personnel with effect from April of next year. Air Officer-in-Charge of Administration and then Senior Air Staff Officer, F.E.A.F., between 1951 and 1953, Air Marshal Sir Hubert Patch, was A.O.C., No. 11 Group, Fighter Command, from 1953 to 1955. Prior to his present appointment he was A.O.C.-in-C., Fighter Command.

The New Signals Command

WITH the increase in flexibility and mobility of the R.A.F. the demands for ever-better communications, navigational aids and radar have emphasized the growing importance of No. 90 Signals Group, and it has been decided that the status of its Headquarters be raised to Command level. In future the formation is to be known as Signals Command.

There are to be no upgrading of posts or increase in establishments with the change in title and the present Air Officer Commanding, Air Vice-Marshal L. Dalton-Morris, C.B., C.B.E., is continuing in command of the formation. The headquarters of Signals Command is at R.A.F. Medmenham.

1959 Gordon Shephard Competition

THE 1959 Gordon Shephard Memorial Prize Essay Competition, open to serving members of the R.A.F. has the following subject: "So long as the effectiveness of the nuclear deterrent is maintained, it is probable that global war can be averted. But the very success of the deterrent compels Communist Powers to seek to achieve their aims by other methods. It must, therefore, be expected that they will now increasingly concentrate their efforts upon political subversion, economic penetration, and, where the risks to themselves are not too great, indirect military action."

Contestants are required to discuss problems likely to arise from such a change of emphasis and to suggest measures which the Service should adopt to enable it best to meet them. Essays must not exceed 4,000 words and the closing date is April 30, 1959.

The End of Home Command

WITHIN the present financial year R.A.F. Home Command and its two remaining group headquarters are to be abolished. The control of the Air Training Corps and the R.A.F. section of the Combined Cadet Force will pass to Flying Training Command, and the A.O.C.-in-C. of this Command will assume the additional title of Commandant of the A.T.C. Because of the importance of the two cadet forces an Air Commodore is to be appointed as full-time Deputy Commandant.

Home Command was set up in 1950 primarily for the control and training of reservists, auxiliaries and cadets, but has also been responsible for certain regular units. The reduction in these tasks has made it practicable to distribute them between other commands and this has now been done. It is estimated that this reorganization will save about 670 Service and 300 civilian posts, amounting to a long-term saving of more than £750,000 a year.

The long-term uses of the headquarters of Home Command at R.A.F. White Waltham are now under review, but the air cadet staffs will remain for the time being. The two group headquarters are No. 64 at Rufforth, which is to be closed down as an active unit, and No. 61 at R.A.F. Kenley, which already houses other units and will continue in use. The present Commandant of the A.T.C., Air Marshal Sir Douglas Macfadyen, K.C.B., C.B.E., A.O.C.-in-C., Home Command, is to retire from the Service early next year.

Senior Appointments

GROUP CAPT. R. C. AYLING, O.B.E., has joined the staff of Marshal of the R.A.F. Sir William Dickson, Chief of Staff to the Minister of Defence, with the acting rank of Air Cdre. He commanded R.A.F. Marham from 1954 until taking over command of R.A.F. Bassingbourn in 1956. Gp. Capt. J. H. Giles, D.S.O., D.F.C., is to become Assistant Chief of Staff (Intelligence) at Headquarters, Allied Air Forces Central Europe, with the acting rank of Air Cdre. Gp. Capt. Giles has been Chief of the Air Operations Branch at SHAPE since July, 1956.

Group Capt. C. B. E. Burt-Andrews has become the first Commandant of the new Pakistan Air Force Staff College which is to open shortly at Karachi, and is modelled on the lines of the R.A.F. Staff College at Andover. Head of the Far East Defence Secretariat, Singapore, since 1955, Gp. Capt. Burt-Andrews was previously on the Directing Staff of the R.A.F. Staff College at Bracknell. Gp. Capt. J. L. Barker, C.B.E., D.F.C., who has been Air Attaché in Rome since 1956, is to become Commander of the Royal Ceylon Air Force. Both appointments carry the acting rank of Air Commodore.

Honorary Surgeon

AIR COMMODORE G. H. MORLEY, O.B.E., has been appointed Honorary Surgeon to H.M. The Queen with effect from September, 1958, in succession to Air Cdre. D. A. Wilson, C.B.E., A.F.C., on the latter's retirement from the Service. The R.A.F. consultant in plastic surgery, Air Cdre. Morley is at present in charge of the R.A.F. Plastic Surgery and Jaws Injury Centre at Halton.

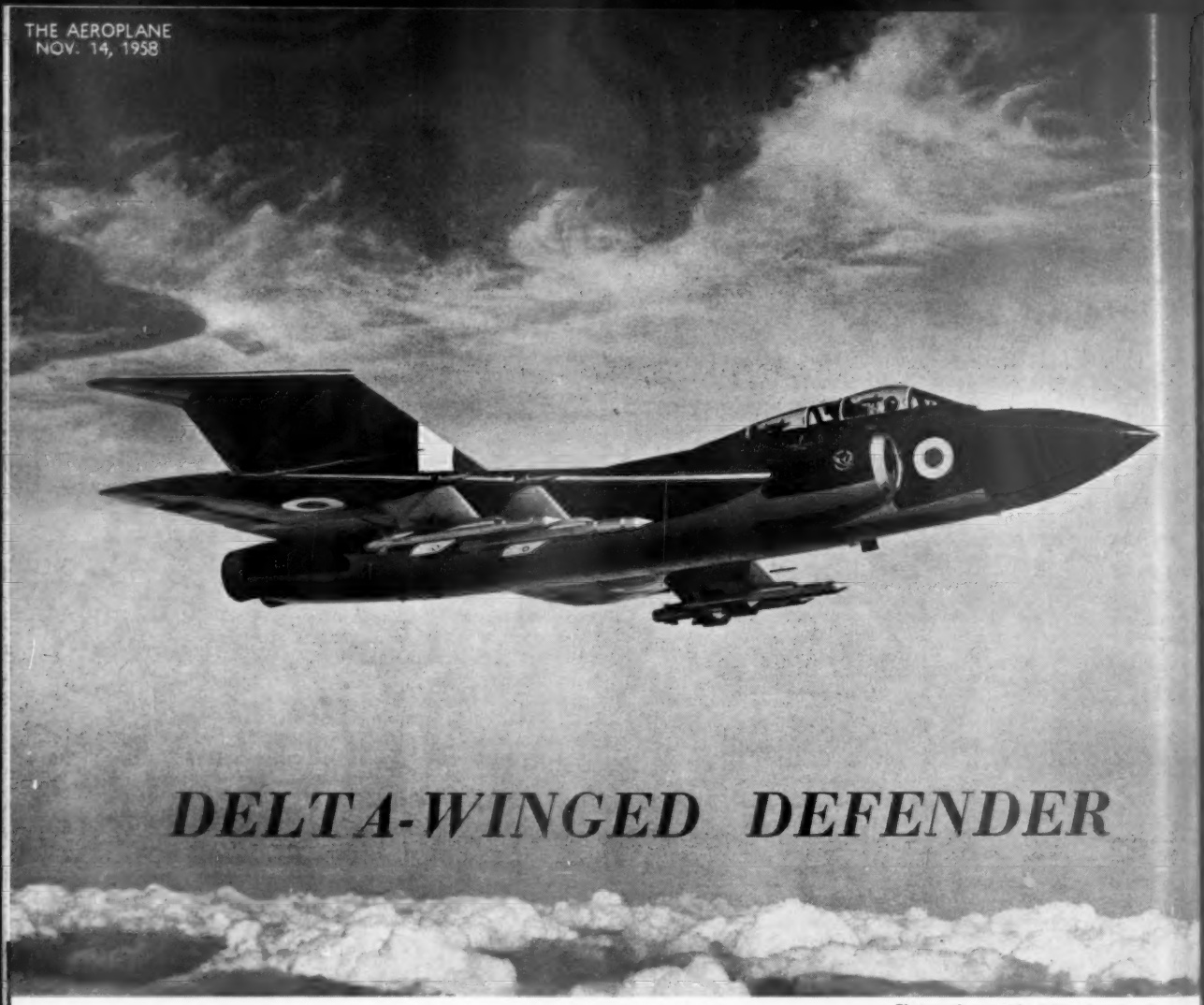
R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Group Captains: O. Gradon, O.B.E., to Air Ministry for duty in the Department of the Air Member for Personnel; R. J. Rackham to Headquarters, British Forces, Arabian Peninsula, for technical staff duties.

Wing Commanders: R. J. E. Boulding to R.A.F. Coningsby for administrative duties; F. J. Mundy to R.A.F. Sopley to command; J. Rennie to the Ministry of Supply; L. S. Laughton to the R.A.F. Staff College, Bracknell, for directing staff duties (with acting rank of Wg. Cdr.).

HIGH-ALTITUDE P.R.—The second Canberra P.R.9 produced by Short Brothers and Harland made its first flight last month. Powered by two 200-series Rolls-Royce Avons, it has increased span and centre-section chord over the Canberra P.R. 7 and an offset fighter type canopy.



DELTA-WINGED DEFENDER

Photograph copyright "The Aeroplane"

THIS article about the Gloster Javelin is largely concerned with progress of the design from the project stage to "airborne hardware" and the subsequent development of the aeroplane which, by January next, will be the sole equipment for R.A.F. all-weather fighter squadrons.

First thoughts on the design of a two-seat day and night fighter by Gloster Aircraft, Ltd., were towards the delta-wing layout, largely as a result of information on the work of Lippisch in Germany which became available in 1945. Two specifications were issued in 1946, F43/46 for an interceptor and F44/46 for a day and night fighter. Glosters made project studies for both specifications, the layout in each case being for a delta wing with delta tailplane, and submitted them to the Ministry of Supply in March, 1947.

Armament was one 4½-in.-bore recoilless gun or four 30-mm. cannon. The recoilless gun was an interesting halfway house between an aircraft cannon firing shells and a rocket projectile. It was developed at Fort Halstead. On firing a shell, a counter-weight of mass equal to the shell was ejected rearward so that there was no recoil reaction on the airframe. The gun was suggested in two forms, as a single-shot tube and as a gun barrel with a 2½-ft.-dia. and 5-ft.-long magazine like that of a revolver pistol.

Glosters received an invitation to tender and produced two further projects meeting specifications F43/46 and F44/46, one of conventional layout and the other of delta planform.

The Ministry of Supply later suggested some changes in both specifications, including the fitment of a large radar scanner in the fuselage nose. A new project brochure was prepared to meet these requirements with the addition that an air-to-air missile was suggested as an alternative to the recoilless guns.

New specifications were issued in February, 1948, F3/48 for a day fighter and F4/48 for a night fighter. Thus, the original related specifications had changed into separate requirements for quite different types of aeroplane. (To jump ahead for a moment, it is interesting to note that F3/48 became the Hawker Hunter and F4/48 the Gloster Javelin.)

At a meeting held on May 21, 1948, the M.o.S. intimated that four prototypes of the F4/48 would be required, and Glosters estimated that the first flight would be in December, 1950, subject to no alterations of the specification. Increases in weight were discussed at a further meeting on July 14, 1948, and a combat weight was fixed, this being decided by the engine powers then available.

The choice of powerplant was between a pair of early Rolls-Royce A.J.65 Avons, then giving 6,500-lb. thrust, or two Metrovick F.9 (later Armstrong Siddeley) Sapphires, each of 7,000-lb. thrust. On this score the Sapphire was chosen. Subsequently, a new design brochure was submitted to the M.o.S. in August, 1948, and the Javelin's basic layout was established.

An instruction to proceed with four prototypes plus one for structure testing was given on April 13, 1949. This order was reduced to two prototypes in November of the same year, this being officially ascribed to an "economy cut"—which at a later date was found to have been a manifestly false "economy." In fact the order was subsequently increased, on March 22, 1951, to five F4/48 prototypes and one prototype of the trainer version.

Detail design work proceeded and by February, 1950, the first issue of structures drawings were completed. Systems drawings were issued to the shops between September, 1949, and June, 1950. Manufacture of the first airframe shell started in April, 1949, and was completed in June, 1951.

The first Javelin, WD804, was moved to Moreton Valence in July for final installation work and preparation for flight. Taxi-ing trials began in mid-October and culminated in the first flight on November 26, 1951, when the pilot was Sqn. Ldr. W. A. Waterton, A.F.C. The flight lasted for 34 min. (See THE AEROPLANE for December 2, 1955, for more information on early flight development.) Power for this and all production Javelins was provided by two Armstrong Siddeley Sapphire turbojets

Early Wind-tunnel Development

Right from the start, the project studies which led to design of the Javelin were for a twin-engined delta-wing aeroplane with a delta tailplane atop the fin. For an all-weather fighter this layout was logical because it gave convenient stowage for radar, nosewheel, crew and engines in the fuselage, the main undercarriage, armament and fuel being contained in the thick wing.

Choice of a delta planform permitted a thick wing to be used because of the relatively low thickness/chord ratio possible with the large root chord used. A thickness/chord ratio of 10% was chosen, although at one stage an 8% ratio was considered before being rejected because of the weight penalty involved.

At first, the position of the maximum thickness of the wing was at 36% chord from the leading edge. Tests with various maximum thickness positions on the same planform suggested that it would be advantageous to shift the maximum thickness farther forward.

This technique, combined with variations of thickness/chord ratio, has been used more recently in designing underwing guided missile pylons of minimum drag for the Javelin FAW7 and 8. It was also a feature of an experimental fin which had increased sweepback on the lower half of the leading edge. This was built, but never flown. A similar fin would have been used on the thin-wing Javelin (see page 726).

Early Gloster project drawings show wing and tail planforms of truncated triangular shape. One of these projects, P.259 of October, 1947, had a wing 1/4-chord sweepback angle of about 39°: wing and tailplane leading-edge sweep angles were 48° and 52° respectively. This project had conventional ailerons and a slab tailplane. Armament was a single magazine-fed recoilless gun in the port wing-root.

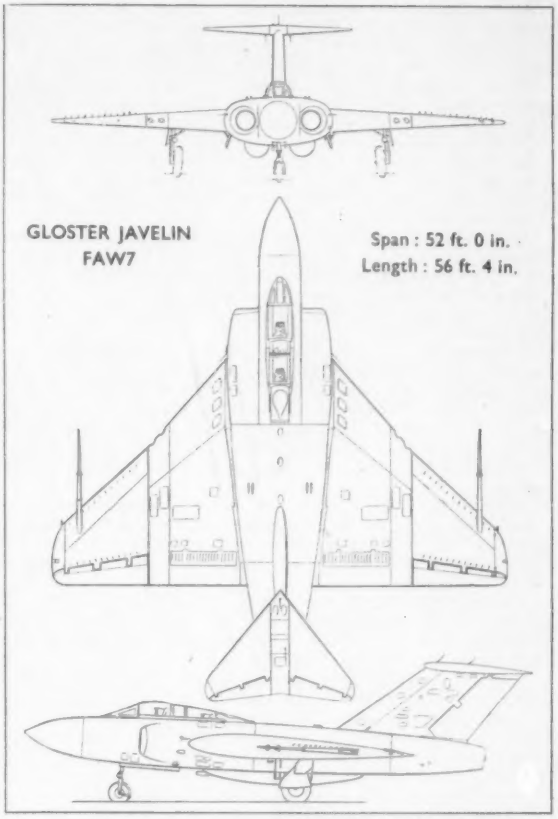
Following the issue of specification F4/48, Glosters drew up project P.272, which was issued on February 26, 1948. This was generally similar to P.259, but incorporated pivoting wing-tip ailerons. Armament was either four single-shot 4½-in.-bore recoilless guns or four 30-mm. cannon.

Following information from the U.S.A. that conventional elevators were quite effective on the North American Sabre at transonic speeds, the slab tailplane was replaced by a fixed tailplane with elevators. The pivoting wing-tip ailerons were also replaced by conventional ailerons. Wind-tunnel tests showed the need for increasing fin and rudder areas. Changes were also made to flaps and air brakes.

Project P.280 incorporated all these modifications and differs little from the first prototype Javelin except that a proposed large "acorn" fairing at the intersection of tailplane and fin was not found to be necessary and the Javelin has never had this fitted. The P.280 project had a wing area of 900 sq. ft., an aspect-ratio of 3 : 1 and the specified powerplant was two Metrovick F.9 turbojets, later developed as the Sapphire by Armstrong Siddeley.

In view of the different attack techniques involved when launching an air-to-air missile, as compared to those for gun-firing attack, it was decided in early 1952 that the Javelin should be modified to increase its manœuvrability at great heights. For this reason the now-familiar cranked leading edge was investigated.

This modification was achieved by extending the aerofoil nose on the outer half of each wing so that the thickness/chord ratio diminishes towards the tips from a position just outboard



of the Aden guns. Manœuvrability is improved because a higher lift is obtained from the wing as a whole before buffeting is encountered at high Mach numbers.

The local lift-coefficient is reduced because of the thinner section, but more lift is obtainable because a higher Mach number can be reached and the Reynolds number and area are both increased. Tipwise outflow, a cause of stalling with swept wings, is reduced because of the reduced taper-ratio on the outer wing panels.

Another change was made in June, 1949, as a result of design studies when wind-tunnel tests at high airspeeds indicated that the fuselage lines in the region of the engine air intakes should be modified. Other tunnel tests resulted in a reduction of taper in the tailplane planform, obtained by sweeping back the trailing edge which was originally at right-angles to the fuselage centre-line.

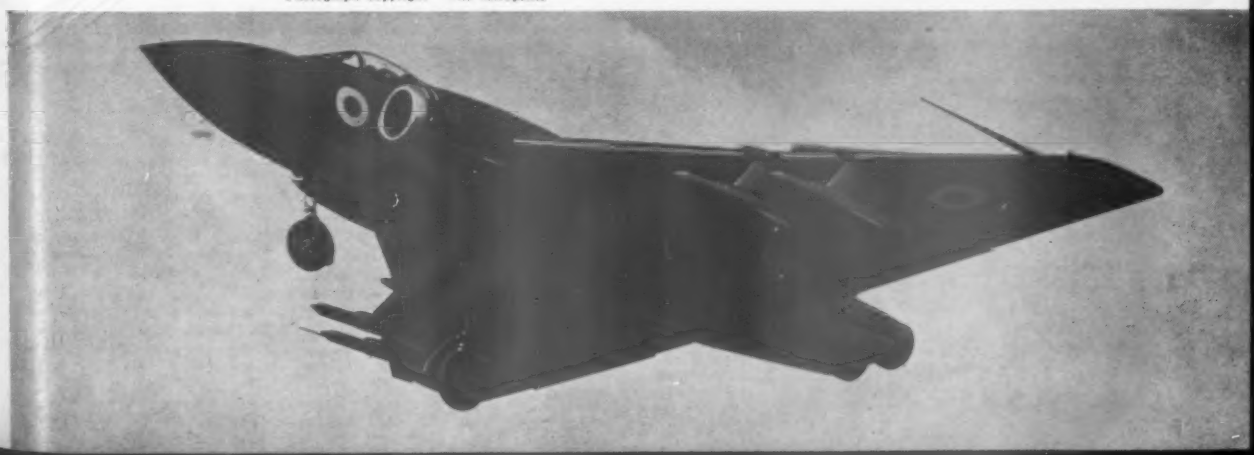
Flight-tests and Later Development

All the above developments were the results of wind-tunnel tests. Naturally enough, actual flight experience with the full-size aeroplane resulted in further modifications being required. At the time of the first flight the results of testing the Avro 707 aircraft were not known and Sqn. Ldr. Waterton was not able to fly one before flying the Javelin.

During the first flight of WD804, buffeting of the rudder was experienced due to interference between engine efflux and air-

MISSILE CARRIER.—Latest Gloster Javelin is the FAW8 armed with four de Havilland Firestreak air-to-air guided weapons and two 30 mm. Aden guns. Powerplant is a pair of Armstrong Siddeley Sapphire A.S.Sa.7R turbojets which, with afterburning, each give 12,300-lb. thrust.

Photograph copyright "The Aeroplane"



flow over the rear fuselage. To improve airflow over the rudder, the rear fuselage was redesigned and lengthened.

To extend the buffet boundaries and increase lift in high-speed flight, the cranked leading edge was introduced on the second prototype WD808 which first flew with the new wing planform on May 28, 1953. (It had originally flown on August 21, 1952.) Other modifications to this aeroplane were a stiffened tail unit to reduce the stick-forces at high speeds and the adoption of a 7.4 : 1 ratio for the elevator control instead of a 5 : 1 ratio to reduce stick-force per *g*. Testing stopped on June 11, 1953, when WD808 crashed and Peter Lawrence was killed.

This accident resulted in an investigation of stalling characteristics at very high angles of attack when "super stall" sets in. This condition arises at speeds under 80 knots with flaps down. The nose of the aeroplane rises, the "super-stall" condition starts and becomes dangerously self-stabilizing at a very high rate of descent.

Investigation of stalling behaviour at the R.A.E. with wind-tunnel models had been limited to an angle of attack well above the normal stall, but from further investigations at higher angles there emerged the "super-stall" phenomena. Pitch-up is not very violent with the Javelin at the stall, but a more serious problem is an effect equivalent to the wing suddenly acquiring a large angle of negative dihedral at large angles of attack.

Flap angle has an effect on the development of "super stall" and the adoption of vented or semi-slotted flaps has alleviated it. The main cause of the trouble emanates from tip stalling of the wings which rapidly spreads as the angle of attack increases.

Leading-edge droop was investigated and model tests were made with both exaggerated droop and a more moderate profile. Even the very pronounced droop had little effect and so attention was next paid to leading-edge slats.

Two types of slat were tried out on the outer portions of the wing: one of constant-chord and the other of constant percentage chord, the second being by far the best. A 2/9th scale wind-tunnel model with working slats gave very promising results. A trial installation was made and flown on a Javelin with the result that the stall became innocuous.

Naturally enough, a weight penalty (300 to 400 lb.) was involved in fitting slats and the official view was that this could not be accepted. For this reason, a stall-warning device was developed and the slats were not made a standard fitment.

The stall-warning system takes the form of a small metal plate mounted on hinges normal to the upper surface of the wing near the tip at mid-chord. At the onset of a stall, the plate is sucked forward by the large low-pressure region developing over the nose of the wing and breaks a micro-switch contact to operate a warning buzzer for the pilot.

Aerodynamic Refinements

To further extend high-speed buffet boundaries—necessary with the increased thrust available from later marks of Sapphire—tests were made with vortex-generator vanes and thickened trailing-edges on the ailerons. Both additions proved useful and are now standard in production aircraft.

An alternative approach is of great interest because, although it went no further than flight trials, the method has recently reappeared in the U.S.A. This technique is the use of streamlined bodies at the wing trailing-edge to weaken shock waves and reduce separation at high subsonic speeds. Soon to be incorporated in the Convair 600 jet transport, these bodies were model-tested and subsequently flight-tested on a Javelin on April 24, 1956.

The Javelin was first flown with streamlined bodies located just inboard of the ailerons and was later fitted with smaller bodies at the wing-tips, both projecting for most of their length behind the wing trailing-edge. With bodies fitted, similar results were obtained to the use of vortex-generators and thickened trailing edges on the ailerons. As the last two methods were somewhat less radical and involved small penalties of weight and cost, they were chosen in preference to the streamlined bodies irreverently known by Glosters as "carrots." They have since been termed "Küchemann (or Whitcomb) bumps." A total of about 30 hours was flown with the "carrots."

Leading-edge droop for low-speed handling was not very beneficial, but in a modified form it has proved very useful in improving manœuvrability at great heights and high speeds. The greater leading-edge camber effectively increases the no-lift angle of the wing tips and thereby increases the washout.

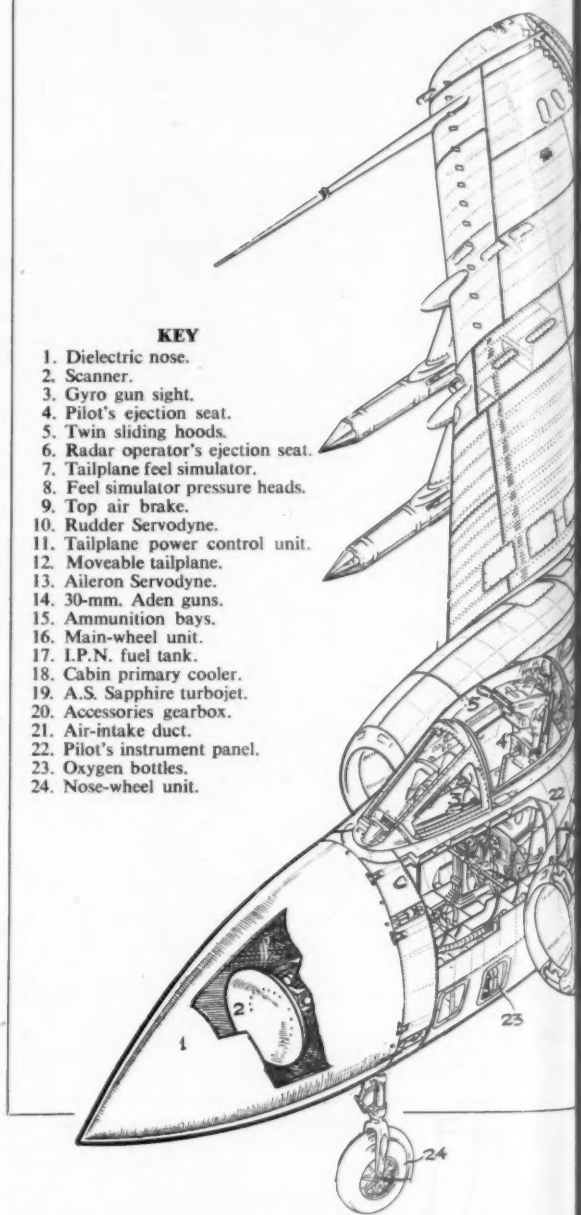
Drag of the Javelin was higher than expected and this was due to the base drag. At the time of the design little was known of all the factors involved, and Area-rule or Küchemann "waisting" was not yet an available technique.

Various base areas were investigated, centred around modifications to the shape of the rear fuselage. The top line of the rear fuselage was raised and a wider tail-end was tried. The best solution was an extension well beyond the base of the rudder and although this did not proceed beyond a trial installation, the time to 40,000 ft. of the Javelin FAW4 and 5 would have been cut considerably had it been incorporated in production aircraft. Another experimental rear fuselage had the two jet pipes brought very close together to give a minimum base area.

Originally projected with a slab tailplane, all standard production Javelins up to the 41st aeroplane (XA629) had an adjustable tailplane with normal elevators. The all-moving tailplane with elevators acting as anti-balance tabs was introduced on XA629, the first FAW4, as a means of reducing excessive stick-forces at high indicated air speeds. All subsequent Javelins have this type of tail. The first all-moving tailplane had been tested on the second production aircraft, XA545, but this was not representative of the final standard.

A development of which Glosters are particularly proud is the windscreen rain-dispersal system for bad-weather flying. Large quantities of high-speed air are fed to a slot at the base of the windscreen and spread out over it by the main airflow.

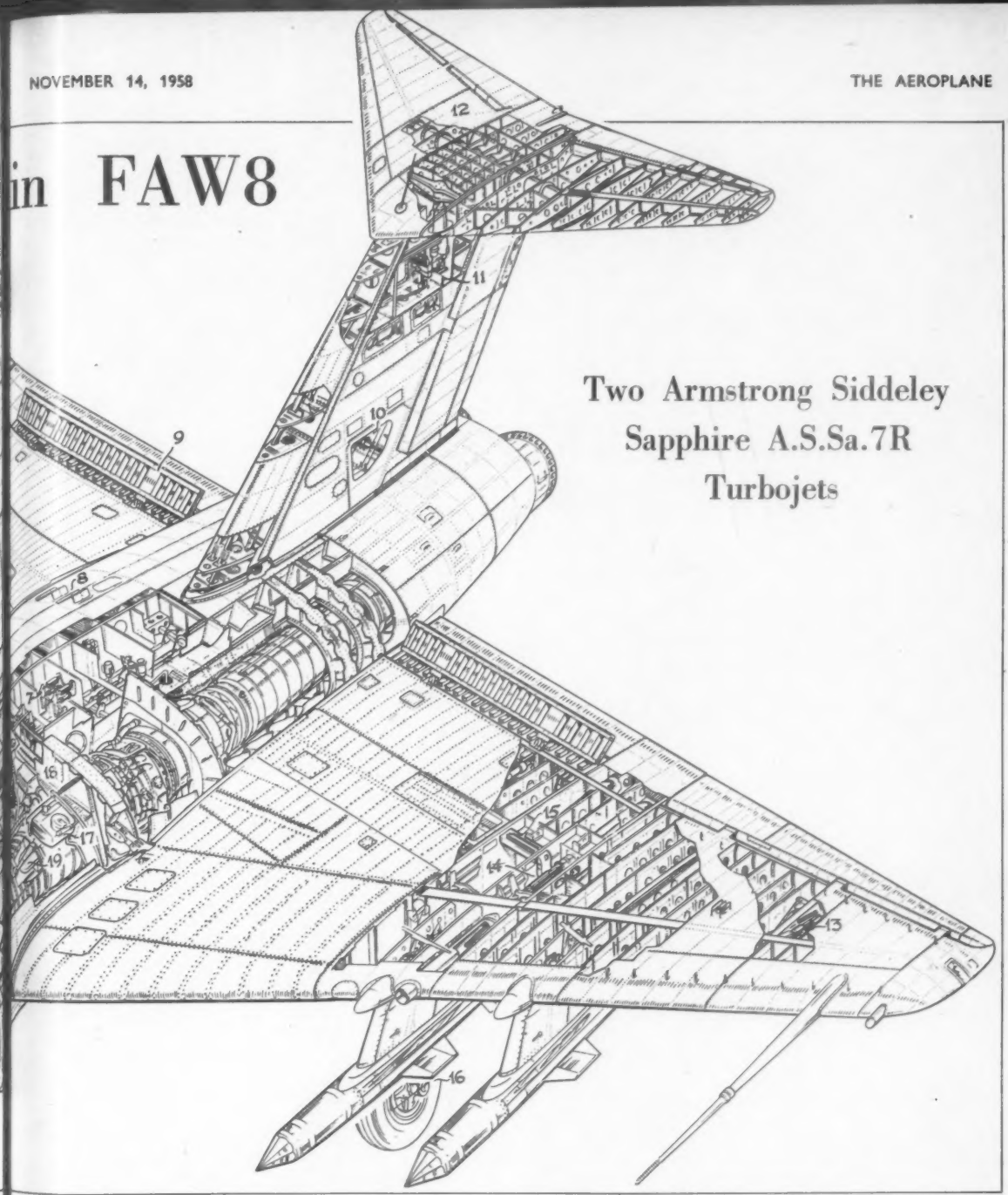
The Gloster



KEY

1. Dielectric nose.
2. Scanner.
3. Gyro gun sight.
4. Pilot's ejection seat.
5. Twin sliding hoods.
6. Radar operator's ejection seat.
7. Tailplane feel simulator.
8. Feel simulator pressure heads.
9. Top air brake.
10. Rudder Servodyne.
11. Tailplane power control unit.
12. Moveable tailplane.
13. Aileron Servodyne.
14. 30-mm. Aden guns.
15. Ammunition bays.
16. Main-wheel unit.
17. I.P.N. fuel tank.
18. Cabin primary cooler.
19. A.S. Sapphire turbojet.
20. Accessories gearbox.
21. Air-intake duct.
22. Pilot's instrument panel.
23. Oxygen bottles.
24. Nose-wheel unit.

in FAW8



Two Armstrong Siddeley Sapphire A.S.Sa.7R Turbojets

This feature is particularly valuable at take-off, approach and landing. A barometric control prevents it operating above a certain height.

Flight-testing resulted in the discovery of an interesting and unexpected phenomenon, that of high induced temperatures of ammunition for the 30-mm. Aden guns. Measurements showed that high shell temperatures were produced and a possible explanation is that small vortices enter the gun barrels and proceed down them to the magazines, the interference flow resulting in the magazines becoming heat sinks.

When plastic covers were tried out on the gun muzzles they soon melted and it was found that a muzzle temperature of 124° C. was reached after nine minutes' flight. The cure for the trouble was found by investigating various lengths of gun muzzle protruding from the wing leading-edge. The optimum result is obtained by using a muzzle which on its inboard side is ¼ in. from the leading edge.

An interesting exercise in applied aerodynamics was the development of launching pylons for de Havilland Firestreak guided weapons. These are swept back from the missiles to the underside of the wings in side-elevation. In end-elevation the shape is more subtle because Küchemann "waisting" is used.

The pylons have a thickness/chord ratio of 10% at top and bottom, reducing to a constant 6% over the central portion. In addition, the chordwise position of the maximum thickness moves back progressively from the bottom to the top as a means of sweeping back the higher-suction isobars.

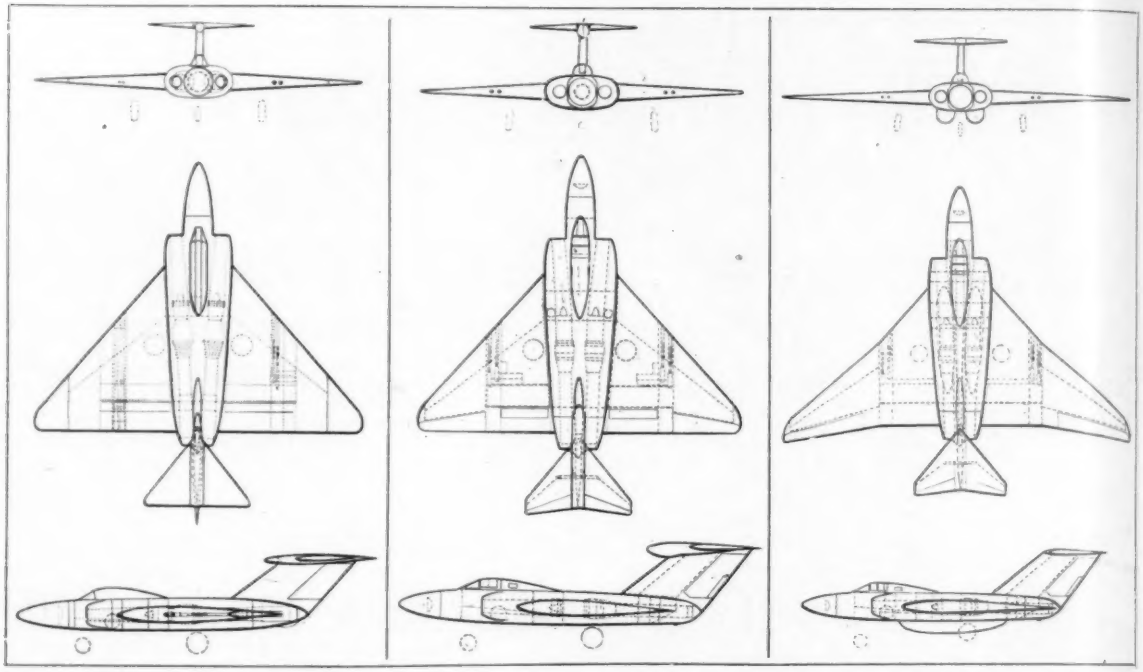
This sophisticated technique has been successful in maintaining the top speed of the Javelin with four Firestreaks very close to that obtained without them. The importance of avoiding any drag-rise is because this would reduce the aircraft's range. Location of pylons in this region is rather tricky because of high local Mach numbers and the results achieved are very creditable.

Javelin Airframe Structure

From the structural design viewpoint, the Javelin has a fairly straightforward and simple airframe. The centre fuselage is a highly redundant structure because of the complex load-carrying duties it has to perform. It consists of the main spar frame, a centre-structure and six frame—skin—stringer segments.

The main spar frame is the most important single member of the fuselage. It carries fork-end fittings which connect on each side with top and bottom booms of the wing main spar.

The spar frame is heavily reinforced at the centre by vertical members which provide attachment for a box beam centre-



EARLY PROJECT.—This layout had pivoting wing-tip ailerons and a slab tailplane. Armament was four 4½-in. bore recoilless guns (port wing) or four 30 mm. cannon (starboard wing).

NEARLY THERE.—Apart from the large acorn fairing at the tail, this project closely resembles the first Javelin. It has conventional ailerons and elevators.

HIGH FLYER.—Long-range escort duties at great altitudes was to be the function of this extended-span project which was not proceeded with.

structure, or keel member, which runs at full depth down the whole centre fuselage. The keel box provides the fin attachments and wing rear attachment.

Frame—skin—stringer segments are attached to each side of the keel in three panels to form the engine bays, the lower segments incorporating runners for installation of the engines. The frames, other than the spar frame, are flanged light alloy pressings reinforced by light alloy extrusions with extra reinforcement on three frames which carry engine mountings, the fin front attachment and the wing spar rear attachment respectively.

The front fuselage is based on port and starboard inner structures. These each consist of the cabin wall and nosewheel bay webs, stiffened on the outer sides by contour frames and intercostal stiffeners.

Forward sections of the cabin walls, the floor and centre webs of the rear frame are in 3 s.w.g. light alloy to give armour protection to the crew in addition to armour plating on the front frame.

In front of this front frame is the A.I. radar bay, enclosed by a nose radome of dielectric material, and aft of the rear frame—just ahead of the wing spar frame—is the servicing bay.

The rear fuselage, a light, semi-monocoque structure, incorporates engine jet pipe outlet fairings and is attached to the centre fuselage by toggle-action quick-release fasteners.

Fin structure is straightforward and of two-spar type. The front spar has T-section booms while the rear spar booms are of angle-section. There is a double-pin attachment to the fuselage at the base of the front spar and a single-pin rear attachment, the rear spar picking-up the tailplane attachment with a double-pin fitting to take bending loads from the tailplane.

Nose riblets and inter-spar fin ribs are reinforced light alloy pressings stiffened by transverse flutes. The root rib is further reinforced by extruded channel sections. At the bases of the spars are forged joint fittings which attach to a fuselage frame at the front and the stern post at the rear of the centre-fuselage keel member which projects into the light rear fuselage shell.

Plates and Z-section members at the top of each fin spar form attachments for the small fixed portion of the tailplane which spans the width of the fin.

Tailplane structure consists of an unswept central tubular spar of about one-third the span on the tailplane hinge-line, continued outboard to the tips by a swept box spar on each side. The rear edge of the torsion box is formed on each side of the fin by the elevator shrouds.

Mainly because of the self-stiffening effect of the delta planform, the Javelin's wings are very efficient and relatively simple structures held by three-point attachments. The wings are built in two panels, joined at the ends of the main spar and rear spar on each side to the fuselage spar frames.

The main spar of each wing half forms a torsion-box with the leading edge over the complete semi-span. Outboard of the guns, the torsion box extends behind the main spar to the light rear spar forming the aileron shroud. On the inboard part of the wing, essential cut-outs for main undercarriage, ammunition bays, fuel tanks and so on do not allow the use of a complete torsion-box from the main spar back to the flap-shroud rear spar.

The main spar has light-alloy shear webs with T-section high-tensile extruded light-alloy booms. At the wing roots, machined-steel fittings pick up the load from the booms and transfer it to the main spar frame in the fuselage. In this region of load-transference from booms to fittings, the T-section flanges of the booms are tapered off progressively as the fitting increases in size towards the root rib. Kink-loads are transferred from boom flanges to the steel fittings by vertical struts reinforcing the spar webs.

The root ribs are primary members of the wing structure because they must transfer much of the bending-moment loading across the fuselage through the main spar frame. The root ribs and the main spar frame between them form the wing bending system which takes the major flight loads due to lift.

The outer wing panels form complete sub-assemblies attached to the inner wings by two fish-plates which tie across the joint to take full tension and compression loads. There is no butt-facing of shear webs and there is no joint between the webs. Shear is taken by a projecting jointing member. A riveted joint is made on final assembly to complete the torsion-box and take some shear.

A measure of structural efficiency is that the prototype standard Javelin wings failed at 114% ultimate design load and the fuselage at 118%. Subsequent testing of a production aeroplane produced failure at 115% ultimate loading, at a greatly increased aircraft weight.

Controls, Systems and Equipment

Elevators, rudder, mass-balanced ailerons, flaps and air brakes are of conventional construction and call for no special comment. Primary flying control surfaces are operated by normal cockpit controls.

The tailplane is hydraulically operated, the elevators acting as anti-balance tabs. Trimming of the tailplane is by a Rotax electric actuator. Pitch auto-stabilization of the Javelin FAW7 is by a Gloster-developed system which will also be fitted to the FAW8.

The FAW7 and 8 have fully powered hydraulic operation of

(*Continued on page* 725)

(*Continued from page* 724)

the rudder, the yaw stabilizer being of Louis Newmark design. The FAW8 has two pitot tubes on either side of the top fuselage, just ahead of the fin, for the duplicated artificial feel systems on the tail control circuits.

The Lockheed Servodyne-operated ailerons are of symmetrical aerofoil section with a fairly pointed nose profile. As now fitted to production Javelins, a blunt trailing edge is used and this varies in depth from 1.49 in. at the aileron root to 0.14 in. at the tip. The object of this is to "fill in" between the main flow lines where the boundary layer has thickened at the trailing edge.

A Sperry autopilot is fitted to the FAW8 and will later be installed in the FAW7. It is an electro-hydraulic three-axis control, with automatic approach and altitude control.

Simple slotted-plate-type air brakes are located on top and bottom surfaces of the inner parts of the wings, a little ahead of the trailing edge. On the undersurface there are vented split flaps immediately ahead of the air brakes.

Undercarriage gear is of Dowty design, the main wheels retracting inwards into the wing roots and a castoring nose-wheel retracting backwards. The Dunlop disc brakes, with the Maxaret anti-skid device, are now of five-pad design replacing the earlier two-pad type which experienced some judder.

Hydraulic services are operated by four pumps driven from the Rotol engine accessory gearbox. Two pumps supply the undercarriage, flaps, air brakes, wheel brakes and other accessories while the remaining pair supply the flying control system. For emergency undercarriage operation there is a compressed-air system.

The accessory gearbox drives two 24-volt generators for the electrical system which operates instruments, heating, lighting, tail trim and cockpit canopy hoods. Inverters produce AC supply for the radar, gun-firing and flight instruments. About 60 items of Rotax equipment include cartridge turbo-starters, high-energy ignition units, rotary actuators and switchgear.

In addition to an AI scanner in the nose radome of the Javelin, other equipment includes GEE, AYF, ILS and IFF. Twin aerials for VHF radio are located under the rear cabin floor.

Original armament of the Javelin was four 30-mm. Aden guns mounted half-way out on the wings, but the standard armament of the FAW7 and 8 is four de Havilland Firestreaks and the two outer Aden guns.

First trials with Firestreak—or Blue Jay as it was code-named—were in July, 1956, when a Javelin FAW4 (XA632 converted by Armstrong Whitworth) was used with dummy rounds. A gyro gunsight and collimator (telescope for line-of-sight adjustment) are fitted in the cockpit and there is a cine-camera in the starboard wing root.

The two crew members are the pilot and radar navigator in tandem. Both are seated in Martin-Baker Mk. 3JS ejector seats and wear ventilated suits.

Engine Installation and Fuel System

Only one type of engine, the Sapphire, has been fitted to the Javelin as standard. Two exceptions are test-bed aircraft, prepared by Napiers at Luton. The first of these was the 19th production Javelin, XA562, which was allocated to Rolls-Royce as a test-bed for the R.A.24R. engine. A second Javelin test-bed, XA552 has two de Havilland Gyron Junior D.G.J.10 engines with afterburning

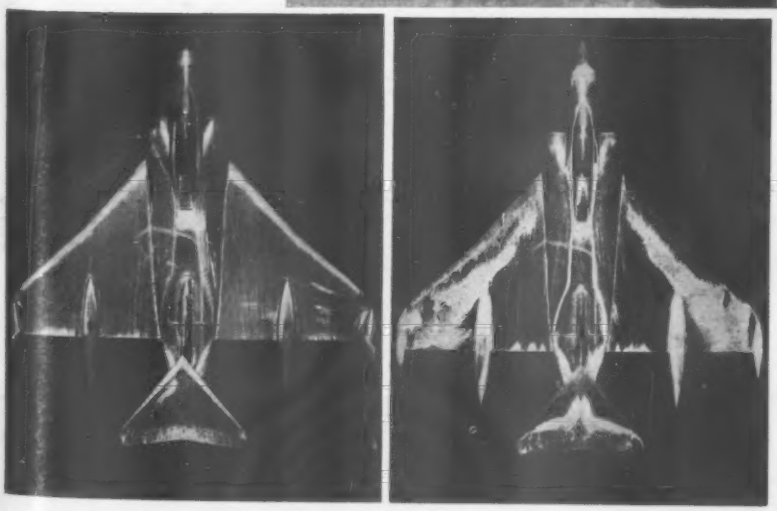
Another test-bed Javelin considered—the 17th production aeroplane, XA560—was to have Rolls-Royce Conway by-pass turbojets, but the Conway-Vulcan presumably took its place.

Choice of the Sapphire for the Javelin was purely on the basis of available thrust. As fitted to the Javelin FAW7 and 8 the Armstrong Siddeley Sapphire A.S.Sa.7R has a static thrust of 11,000 lb. Afterburning of a simple type comes into operation at 20,000 ft. and up to the operating ceiling of the aeroplane, giving 12% more thrust or a total of 12,300 lb. Lucas afterburner control equipment is used.

The 17th production Javelin, XA560, was the first to have the A.S.Sa.7 in place of the 8,300-lb. thrust A.S.Sa.6 fitted to Javelin Mks. 1 to 6.

The two A.S.Sa.7R engines are mounted side by side in the

FULL SCALE.—Two years ago a Javelin was flown with "Küchemann carrots" which bore out the promising model tests and reduced drag. Cost and weight precluded their adoption as standard.



MODEL TESTS.—Flow-visualization shows the effects of varying angle of attack at very high subsonic speed. Left, a low angle, and right, a higher angle. The model on the right is fitted with vortex generators on wing and tailplane in addition to the "Küchemann carrots."

LOOKING AHEAD.—This model of the fully Area-ruled thin-wing Javelin with swept-air intakes was used for free-flight testing. The tailplane has been replaced by a streamline body of equal drag to avoid over-stabilizing. The missiles are evidently Red Dean.

centre fuselage, the afterburner nozzles projecting beyond the rear fuselage shell. Small ram-air intakes for afterburner cooling are mounted on each side of the rear fuselage top decking of the FAW8. These will later be fitted to the FAW7, although this mark of Javelin has already flown with afterburning and without these intakes fitted.

With the rear fuselage shell removed, the two Sapphires are slid in on rails fitted to the centre fuselage structure, the mounting trunnions being locked to the centre structure and to the heavy engine mounting frames. There is also an engine "steady" under each compressor casing.

An auxiliary drive shaft from each engine drives the Rotol gearbox.

The engines are fitted with B.T.H. isopropyl nitrate starters.

Bag-type flexible tanks in the wings and fuselage contain the fuel. There are five tanks in each wing and collector tanks in the fuselage. Air pressure is used to transfer fuel from the wing tanks into these collector tanks. Electric fuel booster pumps supply the engines from the collector tanks and incorporate inverted-flight recuperator valves. Two 250-gal. drop tanks for extra fuel can be carried under the fuselage and four 100-gal. tanks can replace the Firestreaks under the wings. The fuel flow-proportioning system was developed by Glosters.

Flight refuelling of the Javelin has been investigated although only "dry" hook-ups were made with a Canberra tanker. The probe was fitted to the wing leading edge, behind the pilot, and this made the refuelling process rather difficult. Any further trials would certainly be made with a probe over the nose, as with the Vickers Valiant.

Javelin Development and Later Projects

Two major developments of the Javelin have been worked on and one is proceeding—the Javelin T.Mk.3 trainer. This variant has been ordered for the R.A.F. The prototype WD841, flew on August 20, 1956, when the pilot was Wg. Cdr. R. F. Martin, the chief test pilot. Production T.3s are now flying.

The Javelin trainer has an extended front fuselage, a new cockpit canopy and most of the radar removed. Instead of the large A.I. scanner there is a small radar ranging unit in the extreme nose. When in service the trainers will, presumably, be stationed at the Javelin O.C.U., at Leeming.

Javelins FAW 1, 2, 3, 4, 5, 6 and 7 aircraft are all in service with the R.A.F. and the FAW8 and T.3 will soon join them. One squadron (No. 33) of FAW7s is operational and a second is being formed. Squadrons in 2nd T.A.F. in Germany also fly Javelins. The first squadron to receive the Javelin was No. 46 at Odiham, in December, 1955. In all, about a dozen R.A.F. squadrons will be equipped with the Javelin.

Various extensions to the basic all-weather fighter rôle of the Javelin have been considered at different times. These include a single-seater without radar; a high-altitude escort fighter with extended outer wings; and a proposal to use two Napier Scorpion rocket packs, in the same under-fuselage position as the external fuel tanks.

The other major development, and the most far-reaching of all projected variants, was the thin-wing Javelin with transonic performance in level flight. Glosters submitted a design brochure on this improvement of the F.4/48 specification, in February, 1952, discussions with the M.o.S. and Air Staff continuing for more than a year afterwards.

On December 9, 1953, the first complete draft specification was issued by the M.o.S. and a contract for a batch of 18 aircraft was placed on April 5, 1955. The powerplant was to be a pair of Bristol Olympus turbojets.

The thin-wing Javelin was to be a missile-mount right from the start and had higher load-factors on the airframe design than the Javelin. The larger wing gave more storage space for fuel and permitted a higher speed because of its reduced thickness/chord ratio. One of the first thin-wing projects was P.350, a P.R. version with tail warning radar in the fin "acorn" fairing.

A programme of model testing was started, including the firing of a number of 1/10th scale rocket-powered free-flight models. Later models had Area-rule treatment and swept-back air intakes. Project P.376 had these features, the intakes being swept back at 65°.

A constant wing thickness/chord ratio of 7% was compared with a model of 11% thickness at the roots reducing to 6.5% at mid-span and to 5% at the tips. The latter layout had only slight disadvantage in transonic drag and had the great merit of retaining useful storage volume in the wing roots. It was consequently adopted. Development of the thin-wing Javelin was cancelled at a stage when the first airframe was nearly completed.

It would be an impertinence to sum up the Javelin story in a few words, and any pronounced judgment would be largely a matter of hindsight. The Javelin, like many other aircraft throughout the World, suffered its measure of set-backs and development troubles because it spanned the gap between the subsonic and the transonic fighter.

Today, transonic Area-rule is a classroom subject and many new designs have taken full advantage of it. The Javelin was designed before this knowledge was commonly available and was consequently somewhat limited. So far as Glosters are concerned—and quite possibly in so far as the adequate air defence of this country is affected—cancellation of the thin-wing development was a great pity, because it would have embodied the results of much hard-won experience and new aerodynamic design techniques.

The Guided Missile Development Squadron at R.A.F. Valley will be conducting final acceptance trials of D.H. Firestreak-armed Javelins by the end of this year. Javelin FAW7 and 8 all-weather fighters are proven and reliable aircraft which will be the first R.A.F. aircraft in squadron service to be equipped with Firestreak air-to-air guided weapons.—D.G.

PRODUCTION DELTAS.—Fuselage production lines of the Javelin FAW7 at Gloucester. Major Javelin airframe components are also made by Armstrong Whitworth.

Fairey's Rotodyne Reviewed

DEVELOPMENT of the Fairey Rotodyne was described in detail on November 7 by Dr. G. S. Hislop, M.I.Mech.E., F.R.Ae.S., the chief engineer (aircraft) of the Fairey Aviation Co., Ltd. His lecture was given before a joint meeting of the Helicopter Association of Great Britain and the Royal Aeronautical Society. Points from his talk are summarized below:—

Design Philosophy

When the concept of the Rotodyne was first formulated some 12 years ago, the main aims were an increase in the size of rotorcraft, the elimination of the tail rotor and a simplification of the power drive to the rotor. It later became obvious that a considerable increase in size and speed was necessary if a transport helicopter were to be competitive with fixed-wing aircraft over stage distances of 200-250 miles. Design studies which followed a 1951 B.E.A. specification for a transport helicopter showed this clearly.

Tip-jet propulsion was chosen for the Rotodyne because it eliminated the heavy, complicated and costly transmission system necessary for shaft-drive helicopters. The economic penalties of shaft drive become severe as size and power increase. The tip pressure-jet system allowed the rotor and powerplant to be developed separately and with full confidence that there would be no adverse interaction between them which would introduce undesirable vibration; this did not apply with a shaft-drive system. The disadvantages of tip-jet drive were its noise and high fuel consumption.

When discussing the weight saving of the pressure-jet as compared with a mechanical rotor drive. Dr. Hislop gave a comparative weight breakdown for the Rotodyne and the Piasecki YH-16 Transporter. The weights were respectively: structure, 19% and 22.8%; powerplant, 20.4% and 26.4%; rotor, 13.9% and 13.5%; miscellaneous, 11.3% and 10.4%; disposable load, 35.4% and 26.9%.

The Rotodyne achieves a higher forward speed than a conventional helicopter by employing the "autogyro" configuration. It derives its forward thrust from propellers instead of by tilting the rotor disc; this relieves the rotor of a major part of its task at high speed. During forward flight when autorotating the rotor is tilted rearward and the airflow passes up through the rotor. This brings about a more even distribution of blade-lift coefficient, with the most irregular flow region at the inner end of the retreating blade, which is a much less sensitive position than at the tip. With the conventional helicopter, forward speed is limited by tip stall of the retreating blade, which causes heavy vibration.

A second advantage of the Rotodyne configuration is that its fixed wing supplies lift and thus further relieves the rotor, so that rotor speed and lift coefficient can be reduced, postponing the compressibility rise and lowering rotor drag.

The tip-jet silencer now in use on the Rotodyne gives an overall noise attenuation of 4 db.; a suppressor to give 10 db. attenuation should be up to flight standard soon.

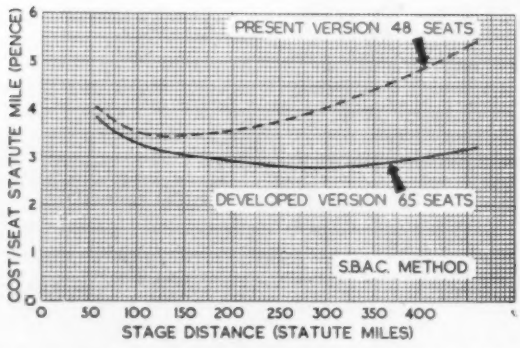
Ground resonance studies have led to the current successful undercarriage of the Rotodyne; springs give low natural frequencies in translational modes, while the rolling and pitching modes are high.

The Rotodyne's basic power units are two Napier Eland turboprop engines which drive four-bladed Rotol propellers. Each engine has a drive shaft behind the turbine connected to an auxiliary compressor via a hydraulic clutch. About 80% of the engine power can be absorbed by the compressor, which delivers air at just over a 4 : 1 pressure ratio to tip-jet units at the end of the rotor blades. Each engine feeds two diametrically opposed tip-jets, so that if one engine or compressor fails the rotor power can be kept at half its maximum.

Piloting Procedure

In helicopter flight during the take-off and landing the Rotodyne's controls are the same as those for conventional helicopters. The only additional control is the selection of collective propeller pitch to give near-zero thrust and drag at any airspeed. There is a small time-lag in tip-jet response to twist-grip movements, but since there is no torque reaction and the rotor speed is less critical than on many other helicopters, the power response is well harmonized with control response. Rotor speed can vary within 16% of the total rotor r.p.m. range, excluding overspeed.

In autorotational flight during the cruise, the controls are as for a standard aeroplane, but their functions differ somewhat. Control of major manœuvres in pitch and roll is by cyclic-pitch



As the Rotodyne is developed its operating costs will fall considerably.

action, but elevator trim is an essential control for establishing the attitude of the fuselage and thus the amount of lift on the wing. This trim control therefore decides the mean cyclic-pitch position for longitudinal control and, consequently, the mean rotor speed.

For autorotational flight 32% of the rotor speed range, excluding overspeed, is available; at any particular airspeed the rotor speed is used which gives minimum total drag. In manœuvres the rotor is allowed to accelerate and decelerate freely above and below this speed and thus rotor speed can be virtually ignored once it has been set up for the cruise.

Transition

A "stage-by-stage" transition technique has been evolved. This gives complete safety at all stages in the flight. The procedure can be followed without a change in the flight path or any noticeable change in attitude, and it permits easy pilot training in the technique. Transition in either direction is completed in about half a minute and test flights have shown that it is both easy and safe. The Rotodyne has already made transitions to and from autorotational flight in instrument conditions at an altitude of 300 ft.

The transition from helicopter to autorotational flight is made after take-off as a helicopter. From the climb-away at 60-80 kts. and 8° collective pitch the aircraft is accelerated at the desired transition height, or in a gentle climb, by slowly increasing the propeller pitch and simultaneously reducing rotor power. At 110 kts. and 4° collective pitch the tip jets are at idling power and the propellers provide almost all the forward thrust; the aircraft attitude is then about 2° nose-up.

With two movements of a single lever on the pilot's console, fuel to the rotor is cut off and both auxiliary compressors are declutched. The rotor speed begins to fall slowly towards a steady autorotation setting, which at this low airspeed is not at all critical. Collective pitch of about 2½ to 3° is then selected and locked without reference to rotor speed.

A small aft movement of the cyclic-pitch control to maintain level flight or climb is made almost instinctively by the pilot and the transition proper is complete. The fuselage attitude is now about 3° to 4° nose-up. Passengers feel no impression of a changing state of flight throughout the sequence.

After transition the aircraft is accelerated to cruising airspeed and the engine control is transferred to the normal constant-speed governor common to propeller-driven aircraft. Throttle and elevator-trim settings are then adjusted for the desired cruising rotor and air speeds.

Transition from autorotational flight is the reverse of that just described. Initially the engines are brought under control of the constant-speed throttle governor and airspeed is reduced to 110 kts. At minimum rotor-power settings the clutches driving the auxiliary compressors are engaged; this takes about 4 sec. and is completed at 100 kts. In test flying the tip-jets are lit immediately after clutch engagement and propeller pitch is reduced to zero for the approach to land. But tip-jet relighting is now often delayed until 200-300 ft. before touch-down and an airspeed of 80 kts. or less. Thus total time at the end of a flight with tip-jets alight is only about one minute as development stands at the moment.

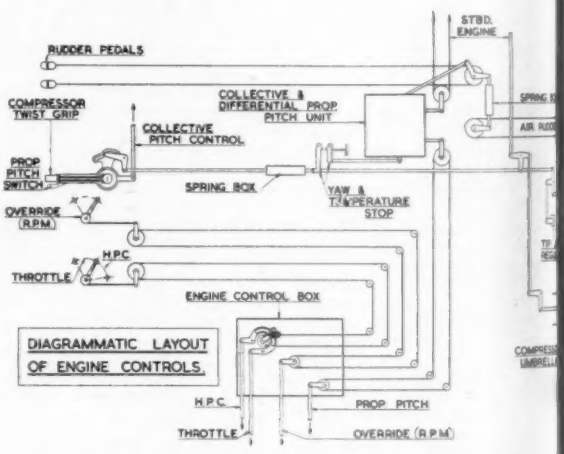
On relight the rotor r.p.m. gradually increases by about 10 r.p.m. Finally, collective pitch and power are applied for a normal helicopter landing.

Tip-jet Silencing

One of the main objections to pressure-jet drive is the noise from the jets. An intensive study of this problem began in mid-1956.

Any tip-jet silencer for the Rotodyne must be strong enough to withstand a centrifugal acceleration of 350 *g* when dealing with gases at 1,800° C. and nearly 60 p.s.i. In addition there is a severe weight restriction which is imposed to reduce blade loads and to avoid blade flutter. Because the aircraft uses tip-jets for only 5-10% of its flight time, the drag of the silenced unit in autorotational flight is very important. Any final design must be a compromise between noise attenuation, drag, weight and strength.

Early flight experience of silencers was considered essential and three designs were developed in parallel. The best of these, flown early in August, gives an attenuation of 4 db. with 5-6 db. suppression in the mid-frequencies. Immediate development of this design should give 6 db. overall attenuation, and it is expected that a 10-db. suppressor which cuts the mid-frequencies by about 15 db. will be up to flight standard before long. Dr. Hislop was confident that the noise of the Rotodyne would not limit its use even in regular city-centre operation.

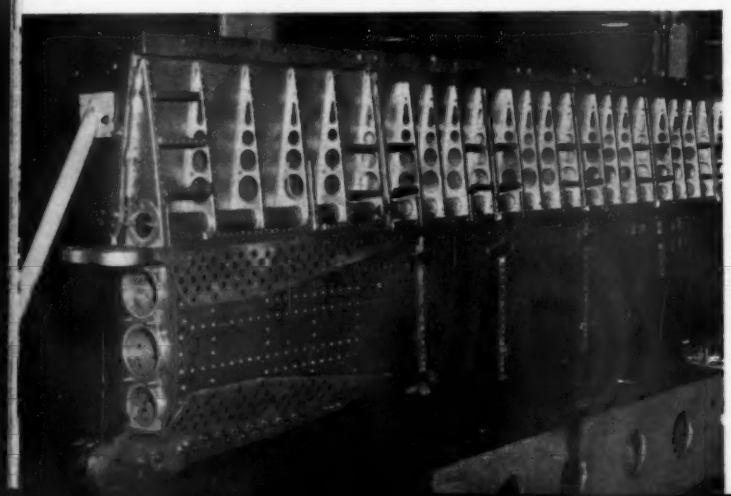


In helicopter flight the pilot controls the collective pitch of the propellers, as well as altering their pitch differentially via the rudder bars for yaw control. In this diagram the "compressor umbrella" is the valve which controls the supply of compressed air to the tip-jet units, and thus the rotor power.

The Rotodyne first flew in November, 1957; between then and the end of September this year it made 127 flights. The first transition was made in April on the 71st flight, after 20 hours flying.

The cruising speed of 160 kts. has been exceeded on a power less than the cruise rating of the engine. Climb performance is phenomenal for such a large aircraft; vertical rates of climb of more than 1,900 ft./min. and forward rates of climb above 2,400 ft./min. have been measured at full gross weight appropriate to the present engine ratings. This all-up weight was fixed as that for which a 200 ft./min. rate of climb could be maintained with one engine at its one-hour power rating.

A 50% increase in the Rotodyne's weight is possible and its speed can also be greatly increased. Faireys believe that cruising speeds of 220 kts. are possible with the Rotodyne's configuration by use of developments which maintain good control for the pilot and reduce rotor drag.



Details of rotor blade construction can be seen in this view; note the ducts for the tip-jet units.

(*Continued from page* 715)

PAST AND PRESENT

Organized by the Royal Society of Arts, three Cantor Lectures on "The Aeroplane" are to be given by three eminent aviation personalities in the next few weeks. On November 24, Mr. C. H. Gibbs-Smith, M.A., F.M.A., will lecture on "The Birth of the Aeroplane"; on December 1, Mr. Peter Brooks, B.Sc.(Eng.), A.C.G.I., A.F.R.Ae.S., technical assistant to the chairman of B.E.A., will take as his subject "The Development of the Aeroplane," and on December 8, "The Future of the Aeroplane" will be the subject of Mr. Eric Mensforth, C.B.E., M.A., M.I.Mech.E., F.R.Ae.S., chairman of Westland Aircraft, Ltd.

AIR BRIDGE MANAGER. — Col. F. J Linck, M.B.E., has been appointed station manager of Air Charter's Channel Air Bridge division at Southend. He was Inspector of Trooping at the War Office before retiring from the Army in 1956.

BELFAST VISITORS.—Seen at Short Bros. and Harland during a tour of inspection are Air Cdre. T. W. Piper, Director of Operational Requirements at the Air Ministry (second left), and Gp. Capt. F. W. Thompson. They were accompanied by Mr. H. G. Conway, Shorts' joint deputy managing director and chief engineer (extreme right), and the company's technical director, Mr. D. Keith-Lucas (second from right).

MARCONI APPOINTMENTS.—Mr. F. N. Sutherland, C.B.E., M.A., M.I.E.E., for 11 years general manager of Marconi's Wireless Telegraph Co., Ltd., has been elected to the board and appointed managing director as from November 5. He is also made a director of Marconi Instruments, Ltd. Mr. Paul de Laszlo, O.B.E., has also been elected to the boards of these two companies as from the same date.

PILOTS HONOURED.—The Queen's Commendation for Valuable Service in the Air has been awarded to, left to right, Capt. N. R. G. Barker (B.E.A.); Mr. C. L. Howitt (A.R.B. test pilot); Capt. J. Monro (B.E.A.) and Capt. A. C. J. Scadding (B.O.A.C.).

EMPLOYMENT STATISTICS.—Personnel employed in the manufacture and repair of aircraft during July and August of this year amounted to 248,500 and 248,000 respectively.

P.R. OCCASION. — The annual reunion of the Air Public Relations Association will be held at the R.A.F. Club, Piccadilly, London, W.1, on November 19 from 19.00 hrs. Tickets, 10s. each, can be obtained from Mr. A. F. Wyatt, Hon. Treasurer, A.P.R.A., Air Ministry, Information Division, Parliament Square House, Whitehall, London, S.W.1.

CZECH LOSS.—News was recently received of the death, after a flying accident several weeks ago, of V. Krysta, the well-known Czech aerobatic pilot, who won the Lockheed Trophy as international champion in 1957. It is understood that Krysta's Zlin Akrobat trainer touched the ground during a very low inverted run, causing him to lose control, and he was severely injured in the subsequent crash. Krysta achieved fourth place in this year's British Lockheed International Trophy Championship at Baginton.

Military Aviation Affairs

LUFTWAFFE STRENGTH.—With the recent contract for 300 Lockheed F-104 Starfighters for the Luftwaffe came Bundestag approval for an additional 200 Fiat G.91 tactical fighters and 60 French helicopters at a total cost of about £135 million. The new aircraft are due in squadron service in about 1963, when the present F-84s and Sabre 5s will be withdrawn, and will bring the total operating strength of the Luftwaffe to 1,326 aircraft. It will then be one of the largest and most efficient air forces in Europe.

HUNTERS FOR JORDAN.—Although British forces have now left Jordan, an R.A.F. mission is to return to train and reorganize the R.J.A.F., which is also to receive a squadron of 12 Hawker Hunters. These aircraft are being paid for by the U.S. under the O.S.P. programme, and some Jordanian pilots have recently undergone advanced jet training in Britain. The former British Mission with the R.J.A.F. was dismissed by King Hussein in 1957, but the Jordanians continued to operate Vampires, and some pilots converted to Sabres in Pakistan.

ATLANTIC CROSSING. — On October 11 a Vulcan piloted by Sqn. Ldr. R. Davenport of No. 617 Sqn. crossed the Atlantic from Cape Harrison, Labrador, to the north of Ireland, a distance of 1,943 miles, in 2 hr. 59.5 min., at an average speed of 649 m.p.h. Returning from a "Lone Ranger" mission, it covered the journey from Goose Bay to R.A.F. Waddington in 3 hr. 53 min.

AT SHOREHAM.—An air display organized by the R.A.F.A. will be held at Shoreham, Sussex, on May 30, 1959.

SERVICE TRIALS.—The first Britannia 252 for the M.o.S. was flown from Short Brothers and Harland, Belfast, to the Bristol airfield at Filton on November 9. It is to undergo Service handling trials at A. and A.E.E., Boscombe Down. These trials will also provide clearance for the very similar Britannia 253s for Transport Command.

A.S.R. MOVE.—The R.A.F. Marine Unit at Bridlington, Yorks, was disbanded at the end of October and the three air/sea rescue launches have been transferred to Calshot. This leaves Bridlington without R.A.F. launches for the first time in 29 years.

CARRIER STORES.—The Royal Fleet Auxiliary "Reliant" has been converted into the first Naval air-stores issuing ship capable of replenishing aircraft carriers at sea. Designed to serve in the Far East, the "Reliant" can carry more than 30,000 different types of aircraft spares and general stores.

NO. 85 SQUADRON.—Following the presentation of the Ingpen Trophy for air gunnery to No. 85 Sqn. by the A.O.C., Fighter Command, Air Chief Marshal Sir Thomas Pike, at R.A.F. Church Fenton on October 7, the Squadron is to be disbanded. The title of No. 85 is being taken over by No. 89 Sqn. at R.A.F. Stradishall.

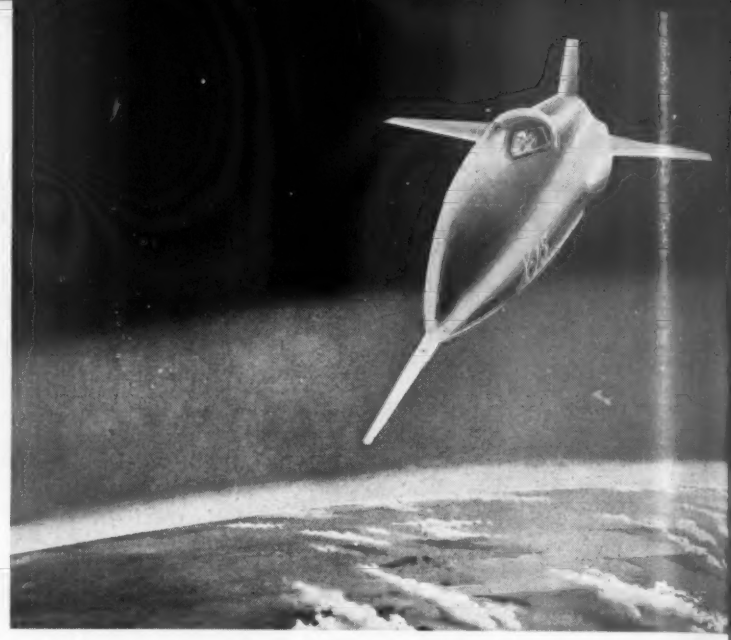
SIDEWINDER FOR NATO.—Ten countries within NATO, plus a further two allied to the U.S., are to receive the infra-red homing Sidewinder AAM by June, 1959. All the recipient countries already operate American fighter aircraft, which will be adapted to carry the Sidewinder.

VULCAN CRASH CLAIMS.—Damage claims arising from the crash of a Bomber Command Vulcan in Detroit on October 24 are to be shared by the United States and the United Kingdom. Under the terms of the NATO "Status of Forces" agreement, the U.K. will reimburse the U.S. for three-quarters of the claims allowed.

ARGENTINE CARRIER.—The aircraft carrier "Independencia," formerly known as H.M.S. "Warrior," was officially handed over to the Argentine Navy at Portsmouth on November 4. Sea trials are to be made before the carrier sails for Buenos Aires this month.

X-15

A Performance Study by "Bisonius"



BUILT by North American Aviation for a joint NASA-USAF-USN research venture, the X-15 promises to be one of the most significant aeroplanes ever built. As the first manned vehicle capable of hypersonic ($M > 5$) speeds, for ballistic flight beyond the atmosphere and re-entry from space, there is good reason why the X-15 has attracted such intense technical interest. The X-15 is the logical descendent of a series of U.S. rocket supersonic research aircraft starting with the Bell X1 and Douglas D-558-1 for which contracts were placed in 1944. Ever since then NACA has rightly placed great importance on the value of full-scale flight research. It is from the wealth of experience gained in hundreds of test-flying hours with the X-series research aircraft that the U.S. has confidently planned the X-15 to play a major rôle in the exploitation of hypersonic flight for the future of aeronautics and astronautics.

Now that photographs have been released and some propulsion facts are available, the likely performance can be estimated with reasonable certainty.

Flight Objectives

The X-15 will be air launched from a Boeing B-52 jet bomber, Fig. 1. It has a liquid rocket motor of 60,000-lb. thrust capable of accelerating it to Mach numbers greater than 5. In spite of the high wing loading of 160 lb./sq. ft. it can climb very steeply at supersonic speeds so that a great variety of flight paths are possible up to altitudes well above present-day aircraft. As performance is so high, restrictions to the flight pattern will be determined mainly by the maximum acceleration acceptable to the pilot, the heating rates and angular limitations of instruments and automatics.

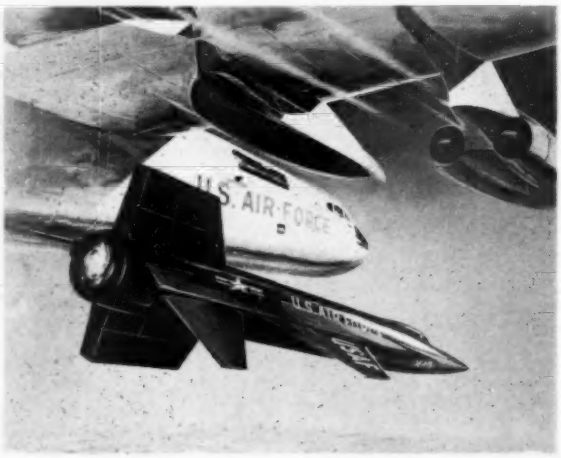


Fig. 1. The X-15 is to be air-launched from an attachment pod under the starboard wing of a B-52 bomber.

Within this wide range of flight profiles there is virtually unlimited scope for research. Instrumentation weighing 1,300 lb. is carried and data will be obtained on:—

- Aerodynamic loads, Buffeting } (140 pressure pick-ups).
- Stability and control, both within and beyond the atmosphere.
- Skin and structure heating (600 temperature pick-ups).
- Re-entry conditions.
- Aeromedical problems.

After the high-speed experiment is completed, the X-15 glides to its airfield and lands on nose wheels and rear steel skids. Its landing speed is reported to be similar to that of modern supersonic fighters.

The wide range of flight conditions to be satisfied by the design can be summarized as follows:—

- Subsonic launch.
- Transonic and supersonic acceleration.
- Hypersonic manœuvres and coasting.
- Ballistic flight beyond the atmosphere.
- Re-entry.
- Supersonic and transonic deceleration.
- Subsonic landing.

There has never been an aircraft required to meet such varied and exacting flight cases. What is also remarkable is that the design compromises have been met without recourse to variable geometry wings or boundary layer control.

The Design

The essential features are shown in the general arrangement drawing (Fig. 2). The overall length is 50 ft., span is 22 ft. and all-up weight quoted between 31,300 lb. and 33,000 lb. The configuration has four unusual features: the large side bulges on the fuselage, the wedge fins of 12 inches trailing "edge" thickness, the markedly long nose in relation ahead of the wing and the anhedral tail. The X-15 configuration has two lines of antecedents: from its own North American F-86 and F-100, and the NACA research aircraft X-1, X-2, X-3 (Fig. 3). The North American aeroplanes show a progressively increasing lowering of the tailplane with increase of Mach number (Fig. 4). A tendency to long forebodies and short tailplane moment arms is seen in the progression along the X-series aircraft.

There are no obvious signs of area rule in the design, which is not unexpected as the X-15 spends little time at transonic and low supersonic speeds where this is most beneficial in reducing drag. At these speeds plenty of rocket thrust is available.

The body side bulges contain fuel systems, pipes, controls and other ancillary gear, but are larger than needed for this duty alone. It is reported that they are there for aerodynamic reasons to improve wing-body interference. At incidence these bulges will create vortices which will be farther apart spanwise than from the body alone. This should increase nonlinear lift

on the body, and reduce any destabilizing effects on the upper fin. This will be beneficial during low-speed approach and landing.

Fin and Rudder Design

Carriage in the B-52 places a limit to the fin height and, with a centre of gravity about 20 ft. from the aft end, the tail volume is restricted. To increase the effectiveness of the available fin area the unusually large single-wedge section has been adopted. This is on average 8 degrees with a trailing "edge" thickness of nearly one foot. At hypersonic speeds this is probably nearly 50% more effective in producing yawing moment than a flat plate or double-wedge section. This advantage can only be had at the expense of base drag but, as will be shown, the X-15 is not bothered by base drag. The rudder is formed by the all-moving upper part of the fin. The lower part of the underneath fin is jettisoned prior to landing.

Base Area and Drag

One of the characteristic features of hypersonic vehicles is a large base area. The X-15 total base area is no less than 24 sq. ft. composed of 8.5 sq. ft. body, 12 sq. ft. fins, and 3.5 sq. ft. body bulges (Fig. 5). The base drags are quite trivial at altitudes above, say, 100,000 ft., as shown below.—

Mach number	4	6	8
Altitude (feet)	150,000	200,000	250,000
Base drag (lb.)	60	20	5

But at 40,000 ft. the base drag is large, e.g., 5,500 lb. at M=2, and 8,000 lb. at M=4. Thus base drag does not impair performance during acceleration to high altitude and will increase deceleration during re-entry at lower altitudes.

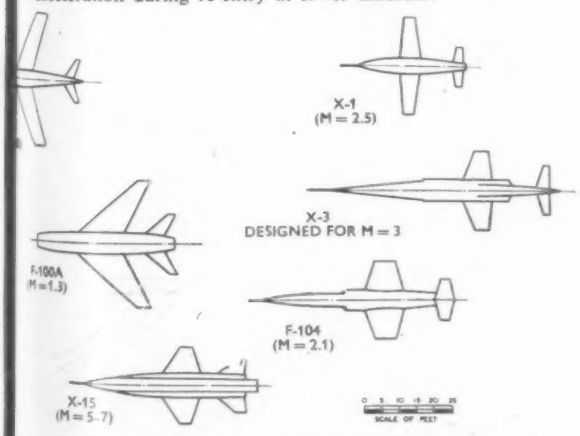


Fig. 3. Fighters and research aircraft which have preceded the X-15 show the trend towards its configuration.

Air Brakes

Air brakes are fitted on either side of the fin trailing "edges" near the body. Their exposed area is 24 sq. ft., contributing a decelerating force of 12,000 lb. if deflected perpendicular to the airflow at a Mach number of 2 at 60,000 ft. During re-entry at M=5, the drag force at 150,000 ft. would be less than a ton. The brakes are extended by a massive hydraulic jack and linkage system as shown in Fig. 6. The jack

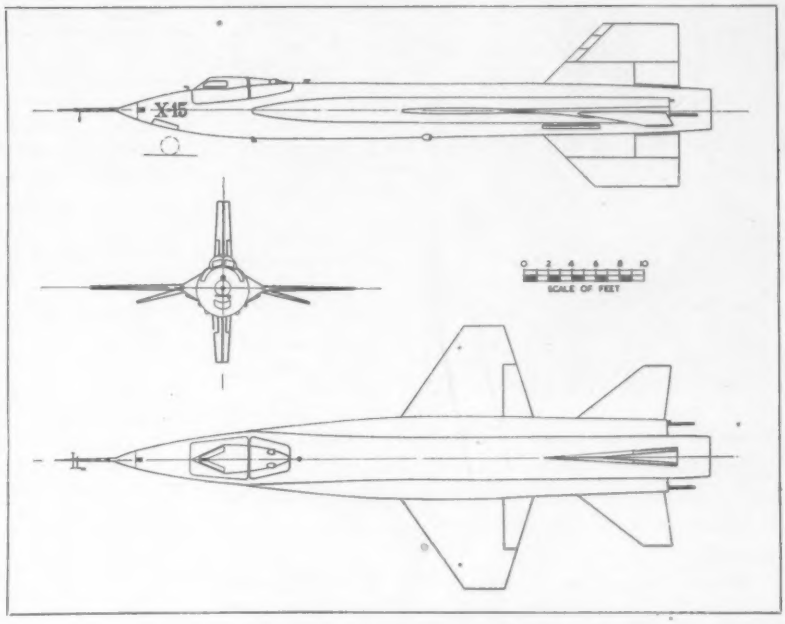


Fig. 2. This three-view drawing of the X-15 shows its long forebody, short tail arm, fuselage-side bulges, anhedral tailplane and wedge fin.

appears to be of the order of 3 inches diameter and at a pressure of 3,000 lb./sq. in. must provide large operating loads. It is possible that parachutes could be streamed from the attachments.

Estimated Weight

A possible weight breakdown might be:—

Item	Weight (lb.)	% A.U.W.
Structure	7,200	23.0
Propulsion unit and mounting	1,050	3.4
Propellent system	250	0.8
Hydraulic system	220	0.7
Primary flight controls	160	0.5
Ballistic control system	240	0.8
Auxiliary power units	80	0.2
Air conditioning and pressurizing system	260	0.8
Remaining services and equipment	1,320	4.2
Special research equipment	1,300	4.2
Pilot	220	0.7
WEIGHT LESS FUEL	12,300	39.3
Maximum fuel	19,000	60.7
ALL-UP WEIGHT	31,300	100

Performance

Possible flight paths after release from a B-52 at 40,000 ft. and speeds of 400-600 m.p.h. are indicated in Fig. 7. Acceleration in level flight as in trajectory (1) leads to high drag and heating rates. At burn-out the Mach number may not exceed 3.5. The vertical climb (3), although within the performance capability of the aeroplane, is unlikely to be used because of control and recovery difficulties. The final height in this case might be about 100 miles. A more useful flight path is shown at (2), where after a 3*g* pull up at low supersonic speeds, the X-15 climbs at 45°. This gives a Mach number near 5 at burn-out, after about 90 seconds. The exact maximum velocity will depend particularly on the fuel/launch weight and the effective specific impulse of the propulsion system.

Above altitudes of about 20 miles the flight paths are

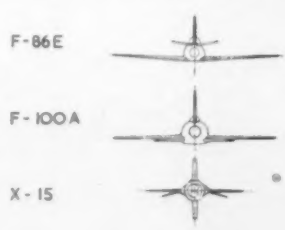


Fig. 4. Tailplanes of North American aircraft have been set progressively lower as their speeds have increased.

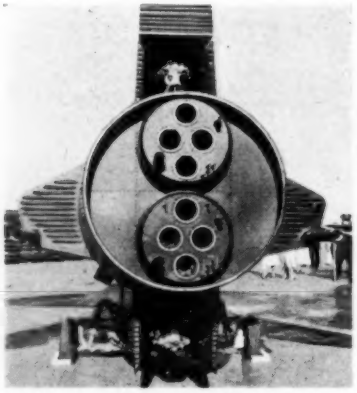


Fig. 5. The total base area of the X-15 is no less than 24 sq. ft.

Levy-Artof Photographs

virtually ballistic and typical cases are shown in Fig. 8. Thus to reach an altitude of 100 miles maximum speeds close to 7,000 f.p.s. and initial climb angles of 60° would be needed. The longitudinal acceleration just prior to burn-out could be as high as 5*g*, if full thrust were used.

Re-entry

Re-entry occurs after the ballistic part of the flight when aerodynamic lift and drag forces are re-established. Any angular misalignment between the aeroplane and the flight path direction will lead to slowly damped oscillation. It is at this part of the flight that the correct use of the rocket reaction controls is vital. Assuming a correct initial alignment with the flight path the changes of Mach number during some representative re-entry glides are shown in Fig. 9.

Speed equivalents at altitudes between 36,000 ft. and 100,000 ft.

M =	1	2	4	6	8
ft./sec.	971	1,942	3,884	5,827	7,769
m.p.h.	662	1,324	2,648	3,973	5,297

Aerodynamic Heating

The X-15 is built of steel and titanium with an outer cladding of Inconel X, which is stated to be able to withstand a temperature of 1,000°C. The degree of aerodynamic heating depends on many factors such as configuration, Mach number, altitude and history of a flight.

To illustrate the order of temperatures to be expected on a 45° climb trajectory with top Mach number of 5, Fig. 10 shows a mean outer skin temperature and aerodynamic heat input rate assuming a turbulent boundary layer. High temperature effects will be accentuated during re-entry and typical values are also shown. After 400 seconds of flight the Mach number is about 1.8 at an altitude of 12,000 ft.

For a more extreme case corresponding to a re-entry Mach number of 7, body temperature might approach 1,000° C. Due to the fact that high heat transfer rates are only experienced during the later stages of the flight, the total heat transferred to the interior should not be excessive. The nose and wing leading edges are reported to be of solid metal to act as a heat sink and there is probably a layer of insulation behind the body skin.

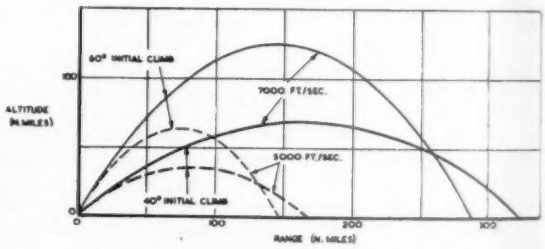


Fig. 8. Ballistic flight paths of the X-15 are shown for 40° and 60° climbs with all-burnt speeds of 5,000 and 7,000 ft./sec.

Extending the Performance

There are a number of ways in which the speed and altitude of the X-15 could be increased. There have been no official

(*Continued on page* 733)

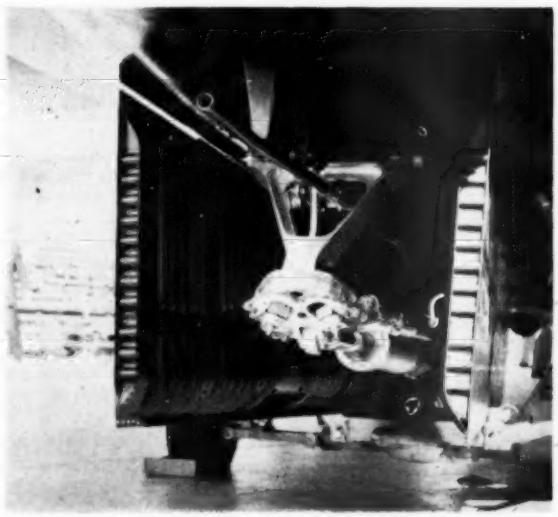


Fig. 6. A powerful jack with a strong linkage operates the outward-opening air brake which forms part of the X-15's ventral fin.

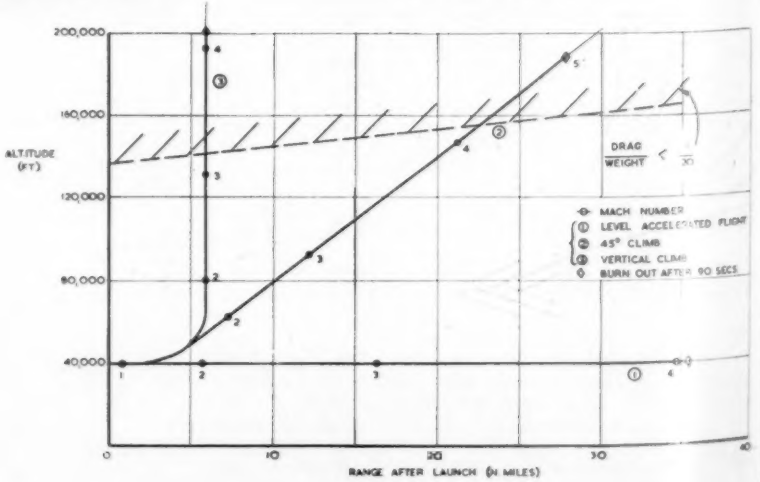


Fig. 7. Possible flight trajectories for the X-15 are shown following its air launching from a B-52 at 10,000 ft. At heights above the hatched line aerodynamic forces are very low.

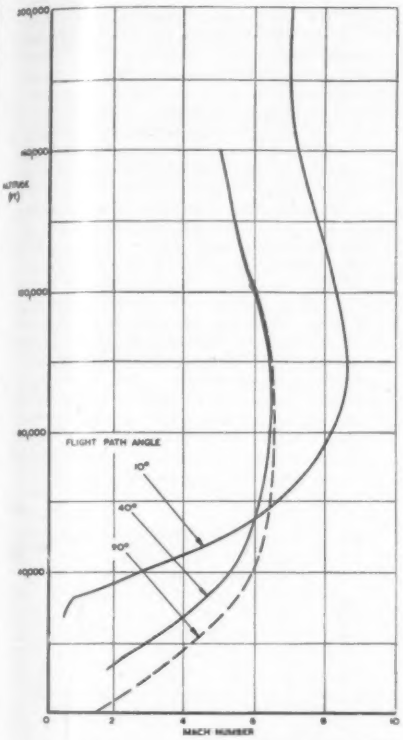


Fig. 9. Left, Mach number is plotted against altitude for the X-15 on its re-entry to the atmosphere at Mach numbers of 5 and 7. Flight path angles are relative to the horizontal; the 90° case is for vertical re-entry.

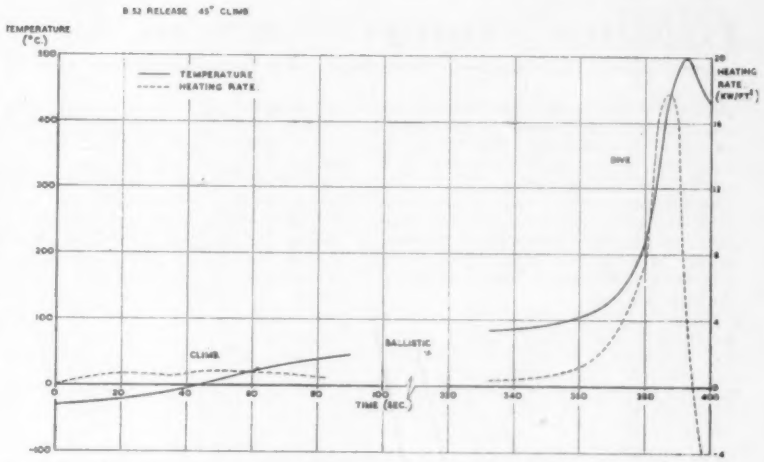


Fig. 10. Above, X-15 temperatures and heat input rates are shown for a mission in which it is air-launched from a B-52 and enters a ballistic trajectory from a 45° climb.

(*Continued from page* 732)

announcements of such plans and the following speculations are offered as interesting possibilities.

(i) **Improved rocket fuel.** If the ammonia/liquid oxygen combination giving a specific impulse of 270 lb.sec./lb. were replaced by a fluorine/ammonia system at a specific impulse of 310 lb.sec./lb., the Mach number at burn-out on trajectory (2) (Fig. 7) would increase from 5 to 7 and the corresponding altitude from 180,000 ft. to 250,000 ft. This probably represents the greatest improvement likely within the time scale of the aircraft.

(ii) **External boosts.** Solid rockets of the type used to ground launch Snark could be used to accelerate the X-15 to about M=2 after a B-52 launch and this would increase the Mach number of trajectory No. (2) (Fig. 7) from 5 to 6.5. A typical weight increase might be 6,000 lb. and provision would have to be made for the rocket thrust loads. This may not be practicable on the present X-15 structure.

(iii) **Launch from supersonic aircraft.** It might be possible to launch the X-15 from the B-58 or the B-70. Higher Mach numbers and altitudes would result from a Mach 2 launch, as shown in Fig. 11.

(iv) **Ground launched from large rocket booster.** It has already been suggested that the X-15 might be launched on a Navaho booster. The engineering and separation aerodynamics would be difficult, but North American has experience of this type of arrangement. The Navaho boost employs liquid fuel rockets of about 400,000 lb. thrust and is 90 ft. long, 7½ ft. diameter and weighs 170,000 lb. at launch. Limiting the forward acceleration to, say, 5*g* would give a separation Mach number of over 5 at 140,000 ft. From this point the X-15 could accelerate to Mach numbers at burn-out exceeding 10 at altitudes in excess of 600,000 ft.

Fruits of Research

Flight research takes time and it will be many months before the maximum speeds and heights will be achieved. During this period data will be acquired on aerodynamic, structural and propulsion behaviour and on the functioning of the many automatic systems. Of particular importance will be flight kinematics and the ability of the pilot to anticipate a safe re-entry path. Another important question is the state of the boundary layer and whether laminar flow can exist. Efforts will be made to establish checks on the considerable amount of wind-tunnel data already obtained.

Although the X-15 has been dubbed the first boost-glide aircraft, this is misleading for it is a research aircraft designed to satisfy a wide set of experimental requirements with good control and pilot safety uppermost. The configuration is therefore not necessarily the best for hypersonic glide efficiency nor in this respect as advanced as many new shapes which have been under investigation in the U.S. for some time. Based on the X-15 experience, however, another generation of more advanced hypersonic configurations must emerge from which we may eventually expect to see the hypersonic boost-glide military vehicle and hypersonic transport.

The X-15 will also give the N.A.S.A. a valuable opportunity to explore briefly some of the aeromedical problems of space flight. Whether the X-15 in its present form will ever be put into orbit is doubtful, but even if it does not achieve this objective, its other contributions will give it a unique place amongst the great technical advances of aviation.

The N.A.S.A., U.S.A.F., U.S.N. and North American Aviation are to be congratulated on producing this first challenger in Man's quest to conquer space. Many in this country will follow the career of the X-15 with great interest—and also the results of its research.

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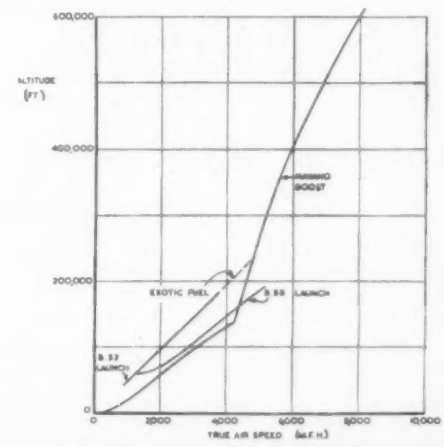


Fig. 11. The performance of the X-15 could be extended by the use of exotic rocket fuels, by air-launching it from a B-58 Hustler or by ground-launching it using a Navaho boost unit. The graph shows its altitude and true airspeed performance in these cases; the curves end at the all-burnt altitude where the X-15 enters a ballistic trajectory.

Gliding Notes

by Dr. A. E. Slater

AS usual at this time of the year, the B.G.A. wants claims for the annual awards to be submitted. The awards are given for the best performances of 1958 by those who have put in claims. This time the trophy for longest distance can be won with either a straight-line flight or a two-legged or three-legged flight, of which every leg but the last must be at least 80 km. (50 miles) long, so 100-km. triangles are out.

Regarding speed records round triangular courses, *Flug-Revue* reports a new rule laid down by the F.A.I. Gliding Commission, that each side of the triangle must be at least 28% of the length of the whole course. For a 100-km. triangle this would be 17.4 miles. This will prevent people making an out-and-return in one direction, followed by an out-and-return in the opposite direction, and then, because they have not made an intermediate landing, calling the whole thing a "triangle."

Adolf "Pirat" Gehriger continues as president of the Commission for another year.

* * *

AN excellent wave appeared over Camphill on Sunday, October 19, and 13 wave flights were made in 11 different machines with a total flying time of 37 hr. 37 min. Only the two club Tutors stayed indoors as the wind was doing 25 knots from W. by N.

John Tweedy made the highest climb with 12,300 ft. in a Sky. L. R. Robertson was second best with 10,000 ft. in an Olympia; but his actual climb was less than this, as he did not dive into the valley after release, so he has not yet completed his Gold C, for which he made the distance leg two years ago with a 300-km. flight from Camphill to Exeter.

In a T-42 (Eagle) Michael Kaye and Brian Hollingsworth not only reached 9,000 ft. but set off across country, using several waves in succession, and landed 55 miles away at Spitalgate airfield. Three people reached just 5,800 ft.—Christina Mercer in a Skylark 2 (is this the daughter of the resident manager and caterer?), Fowler in a Gull 4, and Frodsham in the Krajanek which Ladislav Marmol brought to England from Czechoslovakia 11 years ago. The rest achieved lesser heights between 5,400 and 3,300 ft.

The Derbyshire and Lancashire Club's Skylark 2 led the field in total flying time with 5 hr. 6 min.

The meteorological set-up was a warm front whose ground-level position lay across Ireland at 12.00 hrs. and had reached Llandudno by 18.00 hrs., but after that disappeared off the Air Ministry's weather charts. As to the upper air, the radio-sonde from Aughton, which has replaced the Liverpool station, failed to record any temperatures on the midday ascent; but at that time an inversion of 1° or 2° C., which evidently marked the position of the warm front overhead, was registered at about 7,000 ft. over Aldergrove, 10,000 ft. over Norfolk, and 11,000 ft. over Sussex.

The wind at Aughton increased from 14 knots at the surface through 30 kt. at 3,000 ft. up to a jet-stream speed of 95 kt. at 40,000 ft. However, the wind increase with height from 14,000 to 24,000 ft. was only 3 knots. Nevertheless, the greatest height reached was at the level of the inversion, not the level at which the wind gradient fell off.

There still seems to me to be something suspicious about the way these waves are calculated from the Bernoulli phenomenon of a decrease of pressure with increase of speed in an airstream. An aerodynamicist at Imperial College assures me that this pressure drop is due not merely to the airstream's velocity but to its having been accelerated.

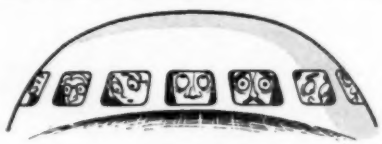
If you hang a portable wind-tunnel out of a railway carriage window so that the air rushes through, there will be no drop in pressure, he says, because the air has not been accelerated, as it is when forced through a wind-tunnel in the usual way. But in predicting lee waves, the custom in the meteorological department at the same college is to calculate the pressure drop in an airstream from its velocity relative to the stationary mountain which starts up the wave system, in spite of the fact that the air has not accelerated from rest, but only from the speed at which the wind approached the mountain in the first place.

* * *

IN a letter from Lloyd Licher, executive secretary of the Soaring Society of America, referring to my report of their National Contests in "Gliding Notes" for September 26, he points out that there was only one Fauvel AV-36 and one Ka-6B in the contest, but they were included in the final results for both the 15-m. Class and Open Class, because they counted as competing in both. This dual marking might be an idea worth adopting in World Championships, so that anyone in the 15-m. Class who is outstandingly good could take his rightful place in the final classification. This would not have done in Poland, because the 15-m. Class competitors were always launched after the others, so would have been doubly handicapped.

Groundabout

Unite and Sight. Reporting another near miss, a paper says "The co-pilot and engineer, who happened to be sitting in the pilot's seat, together pushed the control column forward. . . ." I suppose



the co-pilot's seat was occupied by one of the airline's legal eagles, so useful, if he survives, in putting the company's case at the inquiry.

*

From the Tiger Club's report of their creditable activities during 1958, I especially commend the paragraph on Beverley Snook's crazy flying at Ramsgate, where he "put the fear of God into more people in five minutes than Billy Graham had done in five years."

*

Survival of the Fittest. During one of my sketching tours of aircraft factories, I commented on the health, vitality and bright eyes of the people, mostly executives and men carrying great responsibility, whom I had met. "Ah," said the production manager, "we are the survivors—the others have passed on."

*

Legitimate Competition. Ted Tennant, Folland's chief test pilot, thinks the industry could learn from American sales methods. While visiting the U.S.A., he was told that the supermarkets increased their sales just by providing customers with larger wheeled baskets to put their goods in. If we are to beat the Americans at selling aeroplanes, then clearly, says Ted, what we must have is more and bigger baskets.

*

Wrencontre.* This columnist views the morning mail with mixed feelings. Your friendly contributions are a delight and help at all times and, indeed, sometimes sustain me in adversity, especially when I get a letter beginning "Dear Wren, As you must have considerable difficulty in writing a weekly column . . .". Mind you, I won't say it's easy but all the same, I didn't think it showed that much. I am often asked if I do the writing, but it took an independent operator, Sammy Morton of Morton Air Services, to be independently original. He asked me if I did the drawings.

* Rencontre: An unexpected combat.

*

Wrentente Cordiale. The Union Syndicale des Industries Aéronautiques, the French S.B.A.C., have presented this column with their 50th Anniversary Medal, though the absence of a citation takes some of the gilt off the bronze. When the S.B.A.C. get around to their half-century, in 1966, maybe they'll award me an old Hunter or Javelin—or even a Fireflash or Bloodhound? I'll try to deserve it.

by Wren

Book Reviews

AIRCRAFT AND AIR POWER. By F. G. Swanborough. 107 pp., 5 in. by 8¼ in. Illustrated. Temple Press Limited. Price 10s. 6d.

AT a time when the pattern of military aviation is changing almost daily, it requires considerable courage to publish a handbook on air power, which must be of value as a reference source for several years if it is to be worthwhile. Temple Press were fortunate in being able to call on the services of F. G. Swanborough of THE AEROPLANE to write this addition to their "Power and Speed" series for boys, because he has the knowledge and appreciation of aviation history that are essential if the changing pattern is to be put into perspective.

His final chapter is entitled "Vanishing Man," but the reader is not misled into believing that "black boxes" will take over the military pilot's job completely in the near future, or ever. On the contrary, one of the most interesting sections of the book is that in which the author outlines the work of equipment such as pressure suits, ejection seats and radar aids that enable human pilots to operate in an entirely unnatural environment at height and to do work that is beyond their normal physical or mental capabilities. There is even a brief reference to the time when men will take the place of black boxes in reconnaissance satellites.

Almost every aspect of air power is covered, despite the modest size and price of the book. A brief history of the development of military flying, since the observation balloons of 1794, is followed by a chapter showing how a typical British fighter aircraft progresses from operational requirement to squadron service. Then comes an account of a sortie in a Valiant bomber, which indicates both the complexity of modern "ops." and the way in which devices such as the approach coupler make flying safer and less dependent on weather than it ever was in the past.

Chapter 4 contains short descriptions and specification details of 34 of the most modern combat aeroplanes and is illustrated with clean line drawings, which complement effectively the book's 25 half-tone illustrations. Other chapters deal with research flying, including the present range of VTOL and STOL experiments, military aircraft rôles, carrier flying, army aviation, the organization of an air force and types of armament.

It is to the author's credit that so little of what he has written is controversial: but his remark that "Almost without exception, today's missiles are rocket-powered" seems difficult to justify. There is good reason to believe that ramjets will continue to offer an extremely effective power plant for surface-to-air weapons even in the anti-missile category.

A reference to the NA.39 as a single-seater was obviously due to a momentary lapse of memory; but the statement that the island of an aircraft carrier is on the port side, with the angled deck on the starboard side, is less easily explained.

In general, "Aircraft and Air Power" is both accurate and timely, and these qualities are of paramount importance in a book intended primarily for young enthusiasts. These are the raw material upon which the future quality of the Royal Air Force depends. If they were led to believe that the future R.A.F. officer will be given a button to push rather than an aeroplane to fly, the prospect of attracting youngsters with initiative and the all-important love of adventure would be slim indeed.—J.W.R.T.

GAS TURBINES FOR AIRCRAFT. By Arthur W. Judge. 440 pp., 8¼ in. by 5½ in. Illustrated. Chapman and Hall, Ltd. Price 60s.

TEXTBOOKS on engines by Mr. Judge are well known and enjoy a deservedly good reputation for technical accuracy and straightforward description of the subject. In progress with the times, the author has proceeded from reciprocating engines to "Modern Gas Turbines" and now more specifically to the present title. The introductory chapter of the new book understandably has much in common with the earlier volume because the general history of gas turbines is briefly recounted.

In the second chapter the early application of the gas turbine to aircraft is described, and this is followed by a description of the first principles of design. Succeeding chapters consider performance and component design. Separate treatment is given of the turbojet and turboprop types of engine with several cut-away and sectioned drawings in addition to photographs and diagrams.

Later chapters deal with fuels and fuel systems, the combustion system, the lubrication system, augmented power, starting methods, failure causes, maintenance, silencing, thrust-reversal, special materials and special types of aircraft engines. The final chapter most usefully is devoted to thermodynamic considerations and jogs one's memory with such old friends as Boyle's and Charles' Law before dealing with more complex matters. A useful bibliography is included, there is tabular data on many modern engines, and the index is adequately cross-referenced.

The book is commendably up to date in subject matter, but there are some criticisms to be levelled, apart from a few misprints which do not matter and some which do.

Some statements are debatable, it being not strictly true that the 200-Series Avon is basically the same as the 100 Series, when in fact it is a newer design. Unexpectedly, there is no mention of the pre-War Pescara design. The Lycoming T53 and T55 shaft turbines are not referred to. More surprising, there is no mention of modern Russian engines such as the 12,000 s.h.p. Kuznetsov turboprop or of the Allison T56 Model 501 in the U.S.A.

The use of variable-incidence stator blades is not dealt with and the G.E. J79/CJ-805 is not illustrated in this or other contexts. The T58 is shown, but this interesting design feature is not commented on. Reference is made to the Rolls-Royce "River" class as if this applied to centrifugal-compressor engines only instead of to the whole range of gas-turbine engines.

The most serious criticism is that the approach is too academic. When good sources are used the result is good and vice versa. There is too much pure statement and too little comment. Thus one might imagine that the Napier Nomad and Bristol Orion were still being developed.

A more discursive and opinionated book would be far more interesting to read and would give a closer idea of the present state of the art. To sum up, Mr. Judge's book is very good, so far as it goes. The intelligent reader will be able to make it a useful basis upon which to build a more detailed and intimate knowledge of aircraft gas turbines.—D.G.

AIRCRAFT ANNUAL, 1959. Edited by John W. R. Taylor. 96 pp., 7¼ in. by 9¼ in. Illustrated. Ian Allan, Ltd. Price 10s. 6d.

ONCE AGAIN John Taylor has produced a book which, with its overall correctness and general indication of ability, meets the needs of those members of the younger generation who want a reference to the many aspects of aviation. This new edition is profusely illustrated with more than a hundred pictures (eight of them in colour) of ancient, contemporary and forthcoming aircraft, all of them well chosen and adequate.

Contributors include such well-known specialists as Sir Robert Saundby, Maurice Allward, Warren Shipp and Howard Levy, while there are chapters on such widely different subjects as "The New Luftwaffe," "Behind the P.1," "Man in Space" and the ever-popular "Collectors' Corner"—little-known pictures of vintage types which for various reasons never made the headlines.—H.J.C.

Publications Received

AIR CARRIERS' CARGO LIABILITIES AND IMMUNITIES. By W. E. Astle. 101 pp., 5 in. by 7¼ in. Willerby and Co., Ltd. Price 14s.

THE AIR FORCES OF THE WORLD. By William Green and John Fricker. 336 pp., 9 in. by 11¼ in. Illustrated. Macdonald and Co. (Publishers), Ltd. Price 60s.

AMERICAN ACES OF WORLD WAR II. By Edward H. Sims. 318 pp., 5 in. by 8 in. Illustrated. Macdonald and Co. (Publishers), Ltd. Price 18s.

AND THERE WAS LIGHT. By Rudolf Thiel. 396 pp., 6 in. by 9 in. Illustrated. Andre Deutsch, Ltd. Price 25s.

BEST FOOT FORWARD. By Colin Hodgkinson. 256 pp., 4¼ in. by 7 in. Illustrated. Odhams Beacon Books. Price 2s. 6d.

BRASSEY'S ANNUAL, 1958. The Armed Forces Year Book. (69th year of publication.) Edited by Rear-Admiral H. G. Thursfield. 390 pp. (plus 12 index pp., 26 adv. pp.), 6 in. by 9 in. Illustrated. William Clowes and Sons, Ltd. Price 63s.

C.F.S.—BIRTHPLACE OF AIR POWER. By J. W. R. Taylor. 222 pp., 5½ in. by 9 in. Illustrated. Putnam and Co., Ltd. Price 21s.

ELECTRICITY IN AIRCRAFT. By F. G. Spreadbury. 342 pp., 5½ in. by 8½ in. Constable and Co., Ltd. Price 40s.

FLYING WITNESS. Harry Harper and the Golden Age of Aviation. By Graham Wallace. 272 pp., 5½ in. by 8½ in. Illustrated. Putnam and Co., Ltd. Price 25s.

HANDBOOK OF THE AIRCRAFT INDUSTRY. Edited by J. L. Nayler and T. F. Saunders. 341 pp., 5½ in. by 9 in. Illustrated. George Newnes, Ltd. Price 35s.

A PICTURE HISTORY OF FLIGHT. By J. W. R. Taylor. (Revised edition.) 192 pp., 8½ in. by 11 in. Edward Hulton. Price 35s.

SKY SMUGGLER. By Geoffrey Williamson. 176 pp., 5½ in. by 9 in. Robert Hale, Ltd. Price 16s.

SPACE FLIGHT. (Satellites, space ships, space stations and space travel explained.) By Dr. Carsbie C. Adams. 373 pp., 5½ in. by 8½ in. Illustrated. McGraw Hill. Price 50s. 6d.

VON RICHTHOFEN AND THE "FLYING CIRCUS." By H. J. Nowarra and Kimbrough S. Brown. 208 pp., 8½ in. by 11¼ in. Illustrated. Harleyford Publications, Ltd. Price 45s.

THE WHIP BEHIND THE CART. By Islwyn Williams. 158 pp., 4½ in. by 7½ in. Digit Books. Price 2s.

NOTES AND EVENTS

HEADWIND INFORMATION.—A new meteorological publication gives revised information on the values of equivalent headwinds at 30,000 and 40,000 ft. over an extended network of air routes. This "Meteorological Report No. 20" published by H.M.S.O., price 3s. 6d., supplements Report No. 7 which gave information on winds between 10,000 and 40,000 ft.

ANGLO-U.S. AGREEMENT.—Selling and manufacturing licensing agreements have been signed between the Solartron Electronic Group, Ltd., and Cohu Electronics, Inc., of San Diego, Calif., for "Kintel" range of electronic products made by latter company. Agreement covers whole World with exception of Sweden and North and South America. Solartron is forming a subsidiary company in Sweden under the management of Mr. K. P. Källgren.

DATE TO NOTE.—The 1959 Physical Society Exhibition of Scientific Instruments and Apparatus will be held at the Royal Horticultural Society's Old and New Halls, Westminster, London, S.W.1, from January 19-22.

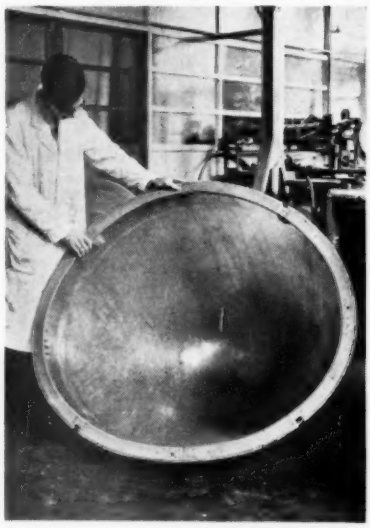
TRANSISTOR CONVENTION.—The International Convention on Transistors organized by the radio and telecommunication section of the Institution of Electrical Engineers will now be held from May 21-27, 1959. During the convention a technical exhibition will cover manufacturing, application, research, development and other aspects of transistors and associated semiconductor devices.

PULLIN MOTOR.—R. B. Pullin and Co., Ltd., has manufactured a new DC permanent magnet motor, the PM1C, which has a rated output of 80 gm. cm. at 5,000 r.p.m. It is a modified version of the PM1 and has improved climatic endurance and a longer life under continuous operation. It can be supplied in a range of voltages.

F.H.P. MOTORS.—The Croydon Engineering Co., Ltd., of Commerce Way, Purley Way, Croydon, Surrey, has produced a pamphlet summarizing its range of special-purpose fractional horsepower motors.

WELD DEFECTS.—The British Welding Research Association has published "Classified Radiographs for Defects in Aluminium Fusion Welds." This describes how to identify defects which can be seen in radiographs. Defects are classified, their origin explained and suggestions for their prevention made. The book, obtainable from the B.W.R.A., 29 Park Crescent, London, W.1, is free to members until February 1, 1959, but costs non-members 10s.

FORGING PRESS.—To increase production of hand forgings, the Northern Aluminium Co. recently installed a 4,000-ton direct-acting hydraulic press at its Birmingham works. It will also be used for closed-die and no-draft forgings and for the pre-working of cast stock before rolling and extrusion at the company's Banbury and Rogerstone works. Several hand forgings of 1,500 lb. each have already been made, and used with the 45,000-lb. hammer already installed, closed-die forgings of up to about 700 lb. can be obtained. Press, originally used in the German Dornier works during the last war, has been extensively rebuilt.



RADAR NOSE.—Seen in a production shop at Filton is a glass fibre radome made by the new Bristol "fluted core" process. This type of radome will be fitted to the four Britannias of Compania Cubana de Aviacion.

NOW IN LONDON.—Buying department of British Aviation Services (Engineering), Ltd., has moved from Blackbushe Airport to company's head office at Silver City House, 62 Brompton Road, Kensington, London, S.W.3, telephone, Kensington 4567.

Company Notices

NEW COMPANIES

Aero Research, Ltd. (613,391).—Private co. Reg. Oct. 22. Cap. £100 in £1 shs. Objects: To carry on the business of designers, builders and constructors of aeroplanes, hydroplanes, etc. Directors: Norman A. de Bruyne, Pyne's House, Duxford, Physicist; Robert J. Fawcett, Mill House, Ickleton, Cambs, company secretary. Sec.: R. J. Fawcett. Solrs.: Few and Kester, Cambridge. Reg. off.: Duxford, Cambs.

Jack Branch (Airfields), Ltd. (613,475).—Private co. Reg. Oct. 23. Cap. £10,000 in £1 shs. Objects: To carry on the business of agricultural contractors, harvesters, land cultivators and clearers, crop sprayers, etc. Directors: Jack Branch, "Silverwood," Ely Road, Waterbeach, Cambs, director of Linton Chalk Pits, Ltd., etc.; Hazel J. Hull, The Starr Inn, Station Road, Waterbeach, director of Linton Chalk Pits, Ltd., etc. Sec.: Derrick E. Waldock. Reg. off.: Winfold Road, Waterbeach, Cambs.

RECEIVERSHIP (APPOINTMENT)

Stanley and Kemp, Ltd. (376,199), aeronautical, mechanical and motor engineers, etc., Bridge Works, Durnsford Road, London, S.W.19.—Gerald J. Burke, of 48 Fruit Exchange, London, E.1, was appointed Receiver on September 9, 1958, under powers contained in mortgage dated March 3, 1950.

New Patents

APPLICATION ACCEPTED

806,324.—Soc. Nationale d'Etude et de Construction de Moteurs d'Aviation.—"Methods of jet deflection and apparatus therefor."—July 25, 1956 (Aug. 12, 1955).

Applications open to public inspection on Dec. 23, 1958; opposition period expires on March 23, 1959.

Aviation Calendar

November 17.—R.Ae.S. Halton Branch lecture, "Flight Refuelling," by P. G. Proctor, in the Branch H.Q., R.A.F. Halton, at 18.45 hrs.

November 17.—R.Ae.S. Henlow Branch lecture, "The Objects and Methods of Aerial Surveys," by J. H. Saffery, in Building 62, R.A.F. Technical College, Henlow, at 19.30 hrs.

November 18.—R.Ae.S. Bristol Branch lecture, "Ram-Jets," by Dr. R. R. Jamison, at Filton House, Bristol, at 18.00 hrs.

November 18.—R.Ae.S. Luton Branch, discussion paper evening, in the Napier senior staff canteen, Luton Airport, at 18.15 hrs.

November 19.—R.Ae.S. Southampton Branch, Sixth Mitchell Memorial Lecture, "Applied Rocket Power," by M. J. Brennan, B.Sc., M.I.Mech.E., F.R.Ae.S. (chief designer, Saunders-Roe, Ltd.), in the Institute of Education, University of Southampton, at 20.00 hrs.

November 19.—R.Ae.S. Weybridge Branch lecture, "The Training of a Production Engineer for the Aircraft Industry," by Prof. J. Loxham, C.G.I.A., M.I.Mech.E., M.I.Prod.E. (College of Aeronautics, Cranfield), at the Apprentice Training School, Vickers-Armstrongs (Aircraft), Ltd., Weybridge, at 18.10 hrs.

November 19.—R.Ae.S. Coventry Branch lecture, "Successful Re-entry into the Atmosphere," by W. F. Hilton, Ph.D., F.R.Ae.S., in the Wine Lodge, The Burges, Coventry, at 19.30 hrs.

November 19.—R.Ae.S. Preston Branch, film evening, at the R.A.F.A. Hall, Preston, at 19.30 hrs.

November 19.—Aircraft Recognition Society, annual photographic competition, in the R.Ae.S. Library, 4 Hamilton Place, London, W.1, at 19.00 hrs.

November 19.—Kronfeld Club talk, "Accidents," by Air Cdre. C. J. C. Paul, C.B., D.F.C., at 74 Eccleston Square, London, S.W.1.

November 20.—R.Ae.S. Second Lanchester Memorial Lecture, "Aeroelasticity—Retrospect and Prospect," by Prof. A. R. Collar, at the Institution of Mechanical Engineers, Birdcage Walk, London, S.W.1, at 18.00 hrs.

November 20.—R.Ae.S. Gloucester and Cheltenham Branch lecture, "Some Aspects of Design of the AW.650 Aircraft," by E. D. Keen, B.Sc., F.R.Ae.S., and others, at St. Mary's College, St. George's Place, Cheltenham, at 19.30 hrs.

November 24.—R.Ae.S. Guided Flight Section lecture, "Inertia Guidance," by J. E. Pateman, at the Institution of Civil Engineers, Great George Street, London, S.W.1, at 18.00 hrs.

November 25.—G.A.P.A.N. lecture, "The Jetstream," by E. Chambers, in the Convocation Hall, Church House, Westminster, London, S.W.1, at 18.30 hrs.

November 25.—R.Ae.S. Belfast Branch, film show, at the Queen's University, Belfast, at 19.30 hrs.

November 26.—R.Ae.S. Christchurch Branch lecture, "Parachutes," by F. B. Jackson, at the King's Arms Hotel, Christchurch, at 19.30 hrs.

November 26.—R.Ae.S. Bristol Branch, Junior Members Paper Competition, at Filton House, Bristol, at 18.00 hrs.

November 26.—Kronfeld Club, talk by T. W. Brooke-Smith of Shorts Gliding Club, at 74 Eccleston Square, London, S.W.1.

November 27.—R.Ae.S. Southend Branch lecture, "Agricultural Aircraft," at the Labour Hall, Boston Avenue, Southend, at 19.30 hrs.

November 27.—R.Ae.S. Isle of Wight Branch lecture, "The Water Barrier has been Broken," by P. R. Crewe, at the Saunders-Roe Sports and Social Club, Church Path, East Cowes, at 18.00 hrs.

Birth Notices

Aedy.—On Nov. 1, at Catterick Military Hospital, to Jane (*née* Fraser), wife of Sqn. Ldr. K. J. Aedy—a son.

Ascott.—On Oct. 26, at Coltishall Nursing Home, to Pam, wife of Flt. Lt. "Tony" Ascott—a son.

Beamish.—On Oct. 27, at R.A.F. Hospital, Cosford, to Betty (*née* Goucher), wife of Gp. Capt. C. H. Beamish—a son.

Dixon.—On Oct. 27, at Belfast City Hospital, to May, wife of Flt. Lt. G. D. Dixon, D.F.C.—a son.

Easton.—On Oct. 31, at Hillcrest, Alnwick, to Betty, wife of Sqn. Ldr. Ivor Easton—a daughter.

Hastings.—On Nov. 1, at Nocton Hall, Lincs, to Margaret, wife of Flt. Lt. T. A. Hastings—a son.

Pullin.—On Oct. 29, at Malmesbury to Sally (*née* Donovan), wife of Sqn. Ldr. Peter Pullin—a daughter.